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OXFORD TECHNICAL MANUALS

THE HANDICRAFT ART OF WEAVING

BY

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THIS WORK IS DEDICATED

TO

MY WIFE AND CHILDREN

PREFACE

For a considerable number of years the interest taken in Arts and Crafts has gradually increased, not only because of the entertaining nature of many of the operations, but also because an extended knowledge of how these operations should be conducted is often of great value to those persons who ultimately become associated with commercial, industrial, and domestic pursuits. In this respect there is, perhaps, no handicraft art which is more valuable than that of weaving, for, in the fundamental processes, the student becomes more or less skilful in the manipulation of threads; this skill first of all acts as an introduction to darning, and later leads up to embroidery, and ultimately to the important subject of textile design.

In this work, which appeared serially in the *Textile Recorder*, the principles involved in darning and in fundamental weaving are described and illustrated in several different ways, while the processes of cloth structure by handicraft methods are systematically arranged. Thus, simple methods of warping, beaming, and frame weaving are fully illustrated and carefully described, and finally the somewhat similar methods adopted in the commercial manufacture of Oriental, Donegal, and Real Axminster carpets are discussed at length.

In addition to fulfilling the main purpose for which the work was written, the many phases involved should be of value to all persons who are pursuing a study of textile manufacture.

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DUNDEE.

THE HANDICRAFT ART OF WEAVING

CHAPTER I

INTRODUCTORY

THE OPERATION OF WEAVING.

The operation of weaving, not only in its simplest form, but also in its most advanced stage, consists of the interlacing of two sets of threads or yarns. For the sake of distinction—most essential in industrial work, although not absolutely necessary for handicraft work—these two sets of yarns receive different names.

1. Those threads which form the length of the fabric, and which are parallel to the selvages, are known as the warp.

2. Those which cross from selvage to selvage, that is, from edge to edge of the cloth, are known as the weft. In many cases the weft is termed filling (mainly in the United States), while in classical literature it is termed woof.

In all cases throughout this work the two series will be mentioned as warp and weft.

WARP AND WEFT.

With certain exceptions, these two sets of yarns, warp and weft, interweave with each other at right angles, so as to become locked, as it were, together, and thus form a compact and more or less solid substance which is known in a general way by several names, e.g. fabric, cloth, texture; and in a particular way by reason of the kind of fibre from which the yarn is spun, from the ornamentation caused by the particular method of interlacing the weft with the warp, from the use to which the finished cloth is to be put, and from other reasons which need not be discussed here.

The number of different ways in which these two sets of yarns can be interlaced with each other to form different patterns is infinite, and the work of arranging these patterns first on paper and then by the warp and weft in the loom is known universally as textile design; on the other hand, the mechanical or manual operation of causing the warp and the weft to interlace with each other in any of these desired orders is known as weaving.

There are several different methods of weaving, and a host of different frames and machines in which or by which the weaving operation is conducted. No matter how simple the frame or apparatus may be, or how complex the machine in which weaving is practised, it is an invariable custom to term such frame, apparatus, or machine, a loom.

The origin of weaving is merged in antiquity; it was certainly one of the very earliest arts, and the high degree of perfection to which it has been brought is due, first to a gradual evolution of the science of textile design and the art of weaving, and second to the phenomenal advances in mechanical engineering.

DID SPINNING PRECEDE WEAVING?

At first sight, one would be inclined to say that spinning would precede weaving, for the cloth is made from yarns which have obviously already been spun. This judgment is not, however, conclusive, for it is highly probable that the first efforts to form a cloth-like article would be by the interlacing of long grasses or reeds, somewhat similar to those which are still used to weave mats and the like. The demand for such articles might conceivably have grown to such an extent that substances other than grasses were found necessary to cope with the requirements or to simplify the process of weaving. Then one might imagine that efforts would be made to form some kind of strand or thread of a longer length. The natural tendency of wool to become entangled would probably cause some person of an inquiring mind to utilise these fibres for the formation of a more or less continuous thread, and after this, the more subtle method of extracting fibrous filaments from flax and similar plants by retting, breaking, and scutching would be attempted with the same object of making a continuous thread. Except for exceedingly small fabrics, and for particular types of fabrics, continuous threads are much more suitable than short lengths for hand-loom weaving or for any other kind of weaving: indeed, for most kinds of weaving the continuous threads are absolutely necessary.

PROCESS OF WEAVING.

It is well known that what is usually called the process of weaving involves many distinct operations - all interesting in their way, and all playing their respective parts in and for the complete machine which we have stated is termed briefly a loom. The various operations which take place during weaving vary according to the type of loom, and also to the kind of cloth which it is intended to produce in the loom. We shall mention these different processes at opportune places.

THE SIMPLEST TYPE OF CLOTH.

The simplest type of cloth is that known as plain cloth, e.g. calico, pillow linen, hessian. This cloth may be made on a small scale by a process similar to what takes place in the operation of darning a stocking. In this case one set of threads remains stationary and parallel, while each thread or pick of the other set is introduced separately by causing the darning needle to pass over and under successive threads when it is moved, say, from right to left, but when the needle is moved from left to right it is made to pass under and over the same threads. The chief difference between darning and plain cloth weaving, neglecting the difference in speed, is that whereas in darning one set of threads only—that formed by the threaded needle—is in motion, both sets of threads are in motion in weaving. Thus, all the threads of the warp are moved together, some upwards and some downwards in horizontal frames or looms, but the weft is introduced singly and successively, pick after pick. (A pick or shot of weft is simply one piece of weft which reaches from selvage to selvage, and the apparatus which causes these successive picks of weft to be introduced is termed a picking motion.)

The movement of the needle from one place to another in the first operation of darning forms a set of parallel threads which may be compared with the threads of a warp, while the movements of the needle crosswise to lock the second set at right angles to the first set in darning may, similarly, be compared with the movements of the shuttle in weaving. The shuttle carries the weft, and it is driven by a blow from side to side alternately by the parts of the above-mentioned picking motion, and each journey leaves a trail or shot of weft between the two layers of warp threads which have been mechanically arranged in these two layers for this special purpose.

CHAPTER II

CLOTH FORMATION BY THE MOVEMENTS OF THE WEFT YARNS

FIRST OBJECTIVE IN WEAVING.

The first objective in weaving is therefore that of making the warp so that the shuttle, or whatever other article is used to control the weft, can be moved from side to side to form the cloth. At this point it might be advisable to give illustrations of the difference between warp and weft, and the effect which is produced by the interlacing of the two sets, as mentioned. The apparatus shall be of the simplest character, so that anyone may repeat the experiment or simple task.

Figs. 1 and 2 show front and end elevations of the frame, which consists of a small block of wood A, about 12 in. long, $2\frac{1}{2}$ in. wide, and 2 in. deep. Two $\frac{1}{8}$ in. wire staples, B and C, are made and driven into the wooden block, as indicated. Any old box might be used for the same purpose if sawcuts are made on two of the upper edges of the box ends. The objection to this latter method is that the threads must be comparatively far apart, whereas with the frame illustrated the threads can be placed as close to each other as desired over the two wires B and C, and fine or coarse threads used at will.

The next requirement is the thread or warp yarn, and the selection of this would clearly depend upon what kind of fabric or band the experimentalist desired to make. As a rule, and especially for beginners, it is a wise plan to select thick yarns, say $\frac{1}{16}$ in. or

FIG. 1.

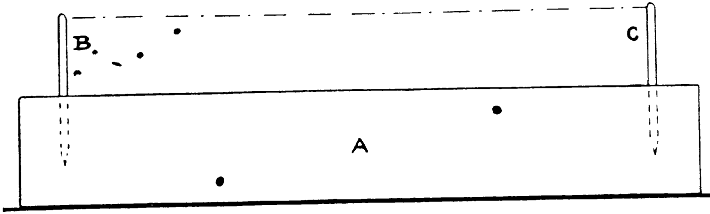
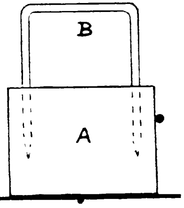


FIG 2.



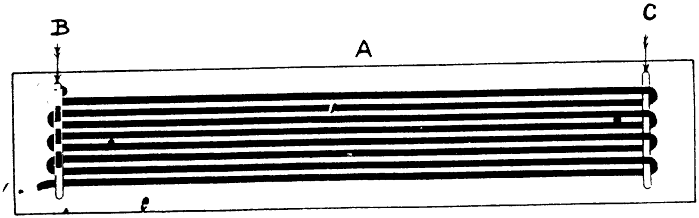


FIG. 3.

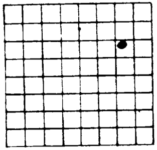


FIG. 4

more in diameter. In ordinary commercial practice the sizes or counts of yarns are invariably determined by numbers. One end of the selected yarn is then tied to the wire B, Fig. 3, and carried from end to end between and partially around the wires B and C until the desired number is reached, when the thread or yarn is broken off and tied to the wire B if an even number is used. Fig. 3 is a plan view of Fig. 1 with eight threads arranged in this way. The simple warp is thus prepared, and since one-half of the threads pass over the wires and the other half under the wires, they will form two parallel layers with a gap of $\frac{1}{8}$ in. The introduction of two or three picks of fine weft, say sewing cotton, at each end B and C will place all the threads approximately on the same level. All is now ready for weaving, or, rather, darning in this case.

DESIGN PAPER.

The order of interlacing the warp and weft threads according to any desired pattern is most satisfactorily

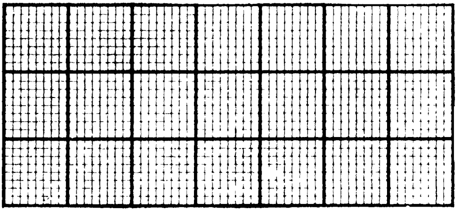


FIG. 5.

shown by means of what is known as "design paper" or "point paper." As a matter of fact, it would be impossible to proceed very far in weaving without such paper. Fig. 4 illustrates a large block of 64 small squares which may be considered not only as eight vertical rows, but also as eight horizontal rows of small squares. Fig. 5 shows several of such groups of 64, or 8 by 8 large blocks, each pair of large blocks being separated by a heavy line. This paper is called "design paper" or "point paper," and it will be seen later that the desired design may be introduced on to such paper to make the subsequent operations easy to follow. It might be stated at once that in practically all cases of a complete design the successive vertical rows of small squares represent the warp threads, while the successive horizontal rows of small squares represent the weft threads. Thus, in Fig. 4 there are eight threads and eight picks represented by the single large block, whereas in Fig. 5 there are 56 threads and 24 picks represented by the 21 large blocks.

SIMPLE INTERWEAVING.

Fig. 6 illustrates the manner in which the weft A is made to interweave with the eight warp threads B by means of the needle C. Two horizontal rows of design paper, each with eight small squares, appear immediately under the warp threads B, and a small arrow from each vertical row of small squares (1, 2, 3, 4, 5, 6, 7, 8) indicates that these two vertical squares refer to the warp thread which is in contact with the point of the corresponding arrow. The lower small square in the first, third, fifth, and seventh vertical rows has been marked in solid black, whereas it is the upper squares in the second, fourth, sixth, and eighth vertical rows which are marked solid black. These marked squares may be taken to represent either warp or weft on the surface of the fabric—the significance of the marking is chosen to suit the convenience of the operator. In the illustration in Fig. 6 the marks represent warp threads up or lifted, and, naturally, the blank or unmarked squares will represent warp threads down or dropped. Hence all marks on the design paper indicate warp threads on the surface, while all blanks on the design paper indicate weft on the surface.

The bent arrow D from the lower horizontal row of eight small squares shows that the needle C would, in passing from right to left, pass over thread No. 8, under thread 7, over 6, under 5, over 4, under 3, over 2, and under 1; this completes the first row of the design. When the needle C is inserted from left to right for the second row of the design as indicated by the bent arrow E, it passes over thread No. 1, under 2, over 3, under 4, over 5, under 6, over 7, and under 8, which completes the second row of the design. The needle C in the illustration is again shown threaded amongst the warp threads in the order shown on the first row of the design and ready for being drawn through. Each time the journey is reversed, the weft bends partially round the outside thread.

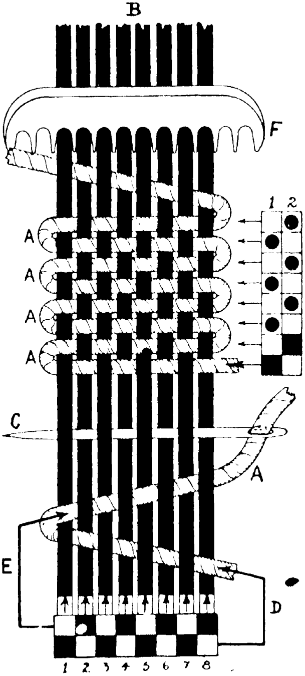


Fig. 6.

It is necessary that each pick of weft, after it has been drawn through as illustrated, should be placed at right angles to the line of the warp threads, so that all will appear somewhat similar to that woven section represented by eight such picks immediately above the needle. In most hand-looms, and in all power-looms, this operation of forcing each successive pick of weft into more or less close proximity with the preceding pick is done by means of what is termed a sley or reed, usually the latter. In cases such as that shown in Fig. 6, however, it may be done by means of a coarse comb F, the teeth of which pass between the threads in front of the last inserted pick, and thus enable such pick to be pushed or pulled towards those which have already been so treated.

The comb should not be removed from the threads, but should be kept there for the purpose mentioned, and also to keep the threads equally spaced or in their proper position, and thus minimise the shrinkage due to the action of drawing the picks tight. The picks are drawn tight in order to form a neat edge or selvage at each side. It is not essential that there should be a tooth of the comb between each pair of threads, as illustrated; the same comb will do for several varieties or setts of warp for such weaving.

On the right of the woven sample in Fig. 6 are two vertical rows of small squares, marked 1 and 2, eight squares in each row. These show how the first two threads interweave with all the eight picks, and it will be seen from the lower design that there are four such pairs of threads, since threads 1 and 2 are exactly the same in the order of marks and blanks as threads 3 and 4, 5 and 6, and 7 and 8. In other words, the unit of the plain weave is on two threads and two picks, or four small squares in all. Fig. 7 shows, on design paper, the order of interweaving of the above eight threads and eight picks, and the four small squares in the bottom left-hand corner two marked in solid black, represent the unit design. The same unit design on two threads and two picks is shown in Fig. 6, while the repetition of this unit appears in solid black circles with the corresponding blanks. The above method of weaving or darning is obviously crude, but it forms the basis of other simple as well as elaborate types of weaving.

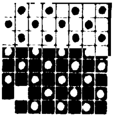


Fig. 7.

A Simple Apparatus.

Fig. 8 is an isometric view of one of these simple wooden blocks and wires which the author used to weave his first pattern. The actual pattern woven is shown immediately to the left of the needle, while the design is drawn on the 12 warp threads to the right of the needle. In this particular case the warp consisted of alternate dark and light threads, and the same two colours of yarn were used for the weft. The design, which is shown at A in one of the detached figures, is made from the unit B. The unit B is known technically as a twill, while the design A is termed a herring-bone or arrow-head pattern. These parts, as well as the diagram or draft C, will be referred to later. In the meantime, it is interesting to see that the effect in the cloth on the frame is the same as that shown at D.

A Cardboard Device.

The simple apparatus which is used by children in certain schools, both in this country and abroad, is a rectangular piece of cardboard, about $\frac{1}{16}$ in. thick say, 6 in. long, and 4 in. broad. Two opposite ends are made with teeth like a saw, and a small hole at the side is provided for the purpose of fixing the end of the warp thread. A photographic reproduction of an American patented card for such kindergarten work is shown in Fig. 9. Two methods of arranging

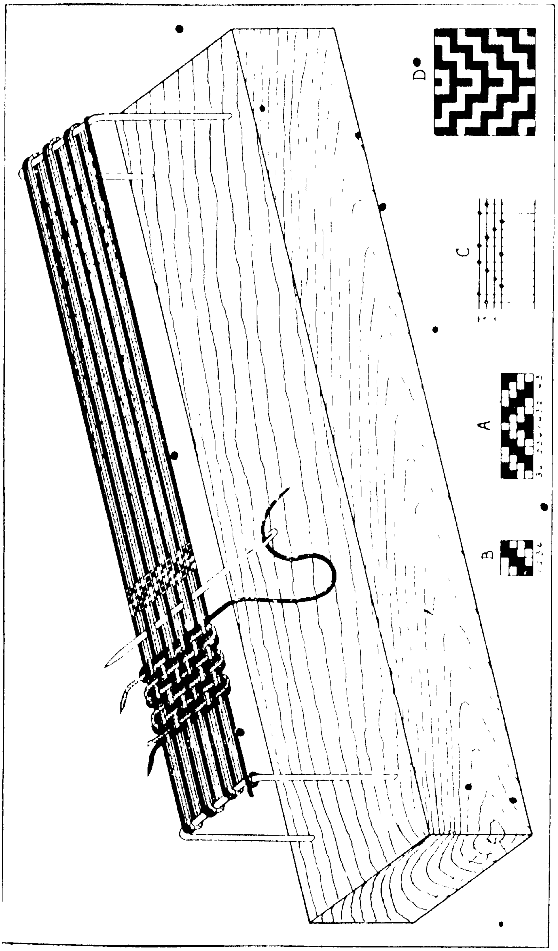


Fig. 8.

the warp thread on such a cardboard are illustrated in Figs. 10 to 12. The cardboard is shown in solid black, and in Fig. 10 there are 14 threads displayed. On the left-hand half of the card in Fig. 10 a continuous thread of warp is wound from end to end, in which case the thread will obviously appear alternately on the two sides of the card, as shown in the end view in Fig. 11. On the other half of the card, on the right hand of Fig. 10, the same continuous warp thread appears, only on the front of the card; see the end elevation of this in Fig. 12. It will be quite clear that the latter method of arranging the thread will require the minimum amount of material. In the former method the threads are more secure, and if fringes are desired, the unused lengths at the back would form the fringes if these lengths were cut midway between the top and bottom of the card after the cloth had been woven or darned.

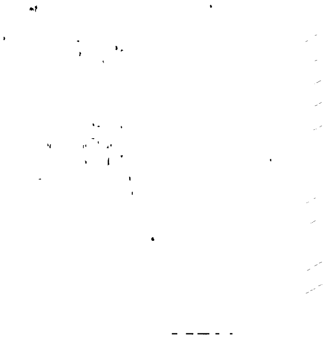


Fig 9.

The distance between each pair of threads depends upon the effect which it is desired to produce, and a word or two might well be said on this subject to prevent disappointments which would often be encountered if the selection were not made judiciously. In Fig. 10 the space between each pair of threads is much greater than the thickness of the thread. In Fig. 3 the space between each pair is equal to the thickness of the thread in that figure. In Fig. 6 the space between the threads is less than the thickness of the thread in that figure. A different number of threads in one inch obtains in the three figures, and the thickness of the threads is not the same in all.

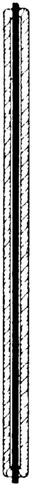


FIG. 11.

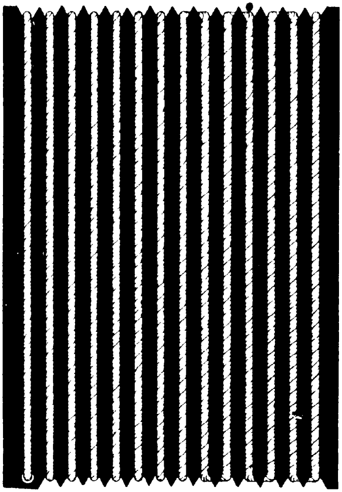


FIG. 10

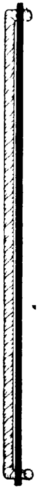


FIG. 12

The technical name for the number of threads in a specified unit width is " sett " or " porter."

It will be quite well understood that, under certain conditions, there are distinct relations between the thickness, or what is often termed the diameter, of the warp threads and the number of such threads which should be placed in a given unit width; also that these relations are subject to modifications if a change is made in the order of interlacing the weft with the warp, i.e. if a different structure of cloth is desired. It is impossible to introduce here the mathematical formulæ which deal with this important branch of weaving, but a full description of the theory of setting appears in *Jute and Linen Weaving*, Part II: *Calculations and the Structure of Fabrics*, by T. Woodhouse and T. Milne. A rough and ready guide may be stated as under:

(1) When the pattern is to be developed entirely by the warp yarns a maximum number of threads per inch is required.

(2) When the pattern is to be developed entirely by the weft yarns, a minimum number of threads per inch is required.

(3) When the pattern is to be developed jointly by the warp and the weft, a medium number of threads per inch is required.

For ordinary plain weaving, that is, for interlacing the weft with the warp, according to the simple design in Fig. 7, a good plan is to leave a gap between each pair of threads in the warp equal to the thickness of the thread, as exemplified in Fig. 3.

A somewhat similar card to that shown in Fig. 9, but rather narrower, is illustrated in Fig. 13. A stripe pattern in the way of the weft and with three distinct colours in five stripes has been woven on this card. The card used for this pattern is simply what is known as a jacquard card for a 16-row machine. To make the card, a full row of 16 holes was cut as shown in the upper part of Fig. 14. Then another row of 16 holes was cut $5\frac{1}{2}$ in. further on the card, and this section cut off through the centres of the two rows of holes. The above card is cut for what is known as a medium-pitch jacquard, and this particular pitch was used instead of a 12-row card in order that the threads of the warp would not be too far from each other.

The weave, or darning, order for the cloth in Fig. 13 is perfectly plain, as shown by the design A in Fig. 14, and the 16 threads of warp in Fig. 13 are arranged as follows:

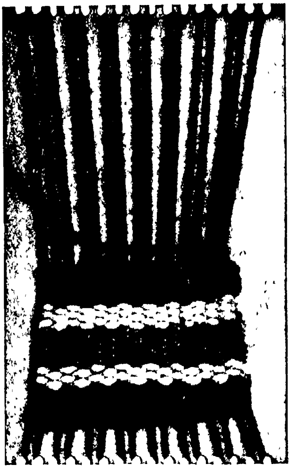


FIG. 13.

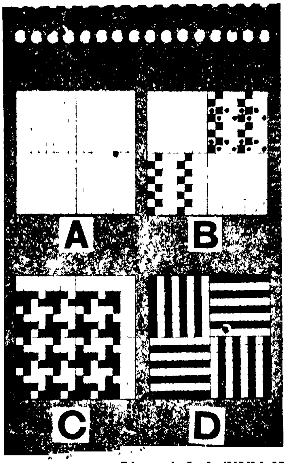


FIG. 14.

A maroon worsted thread was introduced on to the face side only of the card by the method illustrated on the right-hand side of Fig. 10 and in Fig. 12. The warp threads on the card in Fig. 13 are arranged, or in a sett, for the production of a fabric in which the ornament is developed entirely by the weft, as per the conditions mentioned above in (2). The complete order of the warp and weft yarns in the cloth in Fig. 13 is as under:

Warp:

All maroon.
5 threads per inch.

Weft:

8 picks maroon.
4 ,, yellow.
10 ,, sage green.
4 ,, yellow.
8 ,, maroon.

34 picks in 2 inches, or 17 picks per inch.

There are thus more than three times the number of picks per inch as threads per inch, and hence the practically solid-coloured horizontal stripe effect in three different colours. The warp threads are almost completely covered on both sides of the cloth, although the weave is absolutely plain. If the warp threads in Fig. 13 had been wound round the card, that is, both on the back and the front, they would have been better-spaced, and another pattern could have been woven on the other side of the card. Notice how the cloth has shrunk, with respect to the width occupied by the threads, during the operation of weaving. This contraction is general, but variable.

It was essential for the production of the cloth, which is illustrated in Fig. 15, that the weft should show as much as the warp, i.e. the pattern required to be developed jointly, as mentioned in Condition (3). Two threads of maroon (a double thread) were wound round the card in the manner exemplified on the left-hand side of Fig. 10 and in Fig. 11. This double thread, however, was inserted only into eight of the 14 occupied holes, viz. holes 1, 2, 5, 6, 9, 10, 13, and 14. Then a similar double thread of yellow was wound round to fill the remaining holes—3, 4, 7, 8, 11, and 12.

The warping arrangement is therefore:

4 single threads or 2 double threads maroon.
4 ,, ,, ,, 2 ,, ,, yellow.
5 double threads or 10 single threads per inch.

The weft threads are arranged in precisely the same order, and, to be correct, should also have 5 double threads or 10 single threads per inch. Two darning needles, one with maroon weft and the other with yellow weft, were necessary, or rather desirable, for the production of this pattern. If the double threads be considered as one, and so far as the work is concerned they are one, then the interlacing is still the same as that in Fig. 13, i.e. the plain weave as at A, Fig. 14.

When such conditions of warp and weft obtain with regard to thickness and the number per inch, or any other equivalent proportions, the effect which will result from interlacing them in weaving can be displayed by drawing on design or point paper. Thus, the warp in Fig. 15 consists of 14 threads (8 maroon and 6 yellow). The plain weave is inserted very lightly on 14 threads and 14 picks to correspond, and in a manner similar to that in design A, Fig. 14, which, however, shows 16 by 16. Each vertical row of small squares will then correspond to the double warp thread in a similar position in the warp, and, if necessary, a short line of the same colour as the warp can be placed immediately under such thread or threads on the design paper. The method is illustrated at B, Fig. 14; the first stage in the process is shown in the left-hand bottom corner, and the final stage is shown in the right-hand upper corner.

The maroon threads are marked by short black lines on the upper and right-hand sides, although it is usual to do this at the bottom and on the left side.

It makes no difference, however, and the method shown has been adopted to keep clear of the letter B and the design A.

The effect produced solely by the maroon warp threads is shown in solid black squares in the left-hand bottom corner of the structural design B, Fig. 14. The small dots in the vertical rows 3, 4, 7, and 8 would, on the same principle, represent the effect produced by the yellow warp threads; these are left untouched in the structural design B, but the student might, naturally, colour them yellow, and also use a maroon colour for those threads which are shown in solid black. In this way the effect on paper can clearly be made with any two colours more if necessary which it is desired to use for the weaving of the fabric.

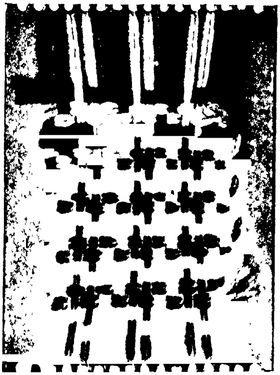


Fig. 15

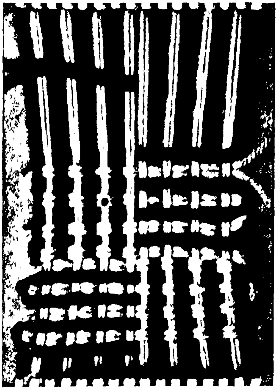


Fig. 16.

If now the final effect on the top right-hand corner of design B, Fig. 14, be examined, it will be seen that the effect produced by the maroon warp threads is again represented by the solid black squares, and, in addition, there are 16 large solid black circles on the four maroon picks those opposite the upper four horizontal marks on the right of the design. These large black circles represent the maroon weft which, since blank squares represent weft on the surface, clearly appears on those lines over the blank or unmarked squares. These large circles should really be replaced by solid squares, but they have been marked as shown so that the effect produced by the maroon weft could be distinguished easily from the effect which is produced by the maroon warp.

When the 14 threads and 14 picks (not 16 by 16, as in B) are marked completely in this manner, i.e. solid marks for both maroon warp and maroon weft, the effect on the design paper is as shown in the design C, Fig. 14, and this is a fair representation of the actual cloth produced in Fig. 15.

The threads of the warp for the cloth reproduced in Fig. 16 are placed on the card in the following order :

Warp :

2 single threads or 1 double thread of maroon.
2 ,, ,, ,, 1 ,, ,, ,, yellow.
2 ,, ,, ,, 1 ,, ,, ,, maroon.
2 ,, ,, ,, 1 ,, ,, ,, yellow.
2 ,, ,, ,, 1 ,, ,, ,, maroon.
2 ,, ,, ,, 1 ,, ,, ,, yellow.
2 ,, ,, ,, 1 ,, ,, ,, maroon.
2 ,, ,, ,, 1 ,, ,, ,, yellow.

2 single threads or 1 double thread of yellow.
2 ,, ,, ,, 1 ,, ,, ,, maroon.
2 ,, ,, ,, 1 ,, ,, ,, yellow.
2 ,, ,, ,, 1 ,, ,, ,, maroon.
2 ,, ,, ,, 1 ,, ,, ,, yellow.
2 ,, ,, ,, 1 ,, ,, ,, maroon.
2 ,, ,, ,, 1 ,, ,, ,, yellow.
2 ,, ,, ,, 1 ,, ,, ,, maroon.

A better and simpler way of indicating this is :

1 double thread of maroon	for 8 double threads.
1 ,, ,, ,, yellow	
1 ,, ,, ,, yellow	,, 8 ,, ,,
1 ,, ,, ,, maroon	

while a still better method in most cases is as under :

<table>
<tr><td>Maroon</td><td>|</td><td></td><td>|</td><td></td><td>|</td><td></td><td>|</td><td></td><td></td><td>|</td><td></td><td>|</td><td></td><td>|</td><td></td><td>|</td><td>= 8</td></tr>
<tr><td>Yellow</td><td></td><td>|</td><td></td><td>|</td><td></td><td>|</td><td></td><td>|</td><td>|</td><td></td><td>|</td><td></td><td>|</td><td></td><td>|</td><td></td><td>= 8</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>16
in patt.</td></tr>
</table>

The latter method shows the arrangement of the threads excellently, especially for complicated patterns, or, indeed, for any kind.

The effect in the woven cloth in Fig. 16 is identical with the effect produced on the design paper at D, Fig. 14; the latter effect has been obtained precisely in the same manner as described with reference to designs B and C in the same figure. Moreover, the weave is the plain one on 2 threads and 2 picks, several repeats of which are shown at A, Fig. 14 – the number shown representing what is necessary to work out one complete unit of the effect as demonstrated at D.

Pretty and Unique Effects.

Many exceedingly pretty and unique effects can be produced by altering the sequence of the warp and weft colouring, and still keeping to the plain weave. Entirely different effects are produced if, without altering the order of the colouring of the threads and picks, the weave in the order of interlacing be changed. We have already seen an effect of this kind in Fig. 8. The warp in this case is 1 thread dark, 1 thread light throughout, and the order of the weft colouring is the same. The order of inserting the needle is shown in the design to the right of the needle, and also detached at A. If the cloth were woven in an ordinary hand or power loom, the threads would be drawn through the mails of the four heddles or leaves in the order shown at C; this is termed the draft of the leaves. The reduction of the 12 threads of design A to 4 different orders is shown by the numerals under the threads; these numerals correspond to what are termed the "healds," and also to the numbers on the four leaves of the healds at C. (See the author's work on *Healds and Reeds for Weaving: Setts and Porters.*) Finally, the four leaves would be operated according to the four vertical rows of small squares in the simple design B, which is termed the "weaving plan." The woven effect displayed at D was made by the method described in connection with Fig. 14, but instead of the plain weave A in that figure, the unit design A, Fig. 8, was used.

The use of a needle imposes no mechanical restriction, but the method of working is excessively slow. Nor does the effect secured compare favourably with those effects which are obtained by sewing, darning, or embroidering on an already woven simple fabric—often a plain open cloth. The famous Bayeux tapestry was made in this way. In the methods which have already been described and illustrated in this work, all the operations were done by exceedingly simple apparatus, and without the help of a solid groundwork of cloth, which is invariably used for the more elaborate ornamentation by embroidery. (See the author's work on *The Finishing of Jute and Linen Fabrics for Mechanical Methods of Embroidery.*)

DIFFERENCE BETWEEN EMBROIDERY AND WEAVING.

This work is not intended to deal with the abovementioned embroidery, but in order that the student may see the difference between it and weaving, Fig. 17 has been introduced. This is a photographical reproduction of an ornamented plain cloth or canvas square in the possession of the author. The central part of the table centre is the original cloth and so is the narrow band which surrounds the ornament and to which the crochet pattern or edging is sewn.

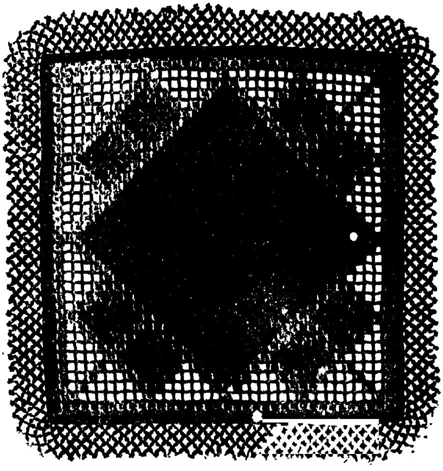


FIG 17

The openwork triangular figures, each of which embraces 16 small square holes, are made by cutting out the necessary number and lengths of threads and picks at the desired places, and stitching over the remaining ones which thus form the lattice pattern. Finally, the star-shaped figures and the supplementary outlines are embroidered with a needle and different colours of yarn.

USE OF COLOURED PAPER SHEETS AND STRIPS.

Figs. 18 and 19 illustrate methods which were at one time practised in training colleges for teachers. Neither warp nor weft in the ordinary way was used, but a sheet of coloured paper, cut for the most part of its length into strips, as illustrated by part of such a sheet in Fig. 18, provided the necessary elements for the warp. The weft was composed of similar but loose strips, and of various colours. Each strip of weft was drawn into its proper place, or in the proper "shed," by a kind of flat needle. A few such picks appear in Fig. 18. One end of the needle was arranged to grip the end of the weft after the free end of the needle had been inserted into the correct place. A completed woven sample of this kind is shown at Fig. 19, while the small designs in Fig. 20, and opposite the various sections, indicate how the design could be placed on paper. The solid marks in each case in Fig. 20 show the unit weave, and where repetition has been considered advisable, crosses have been used.

When fabrics of any reasonable length are desired, it is quite obvious that the cards illustrated in Figs. 13 to 16 are no longer suitable, and, although comparatively long lengths can be woven or darned on the frame illustrated in Figs. 1 to 3 and Fig. 8, it is hardly suitable for anything more than the length between the wires C and D. In short, for the production of a long narrow fabric, such as a belt, ribbon, tie, or the like, it is essential that one should make what is invariably called a "warp" or a "chain"; this is simply a technical term to indicate the group or total number of threads required of a desired length, with special provisions at both ends of the chain to facilitate its transference on to a roller or warp beam and to keep all the threads in their respective positions. In the meantime, however, our object is, first, to show how

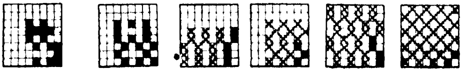


Fig. 20.

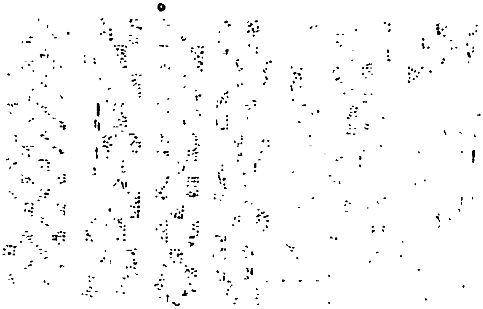


Fig. 19.

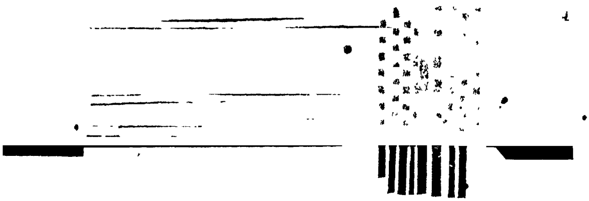


Fig. 18.

patterns can be made; afterwards, the method of preparing warps will be considered.

HOW PATTERNS ARE WOVEN—SOME EARLY EFFORTS.

In order to demonstrate how patterns are woven, it will be interesting to have illustrated and described some of the methods which are used by races who are considered to be less civilised than ourselves. One is, perhaps, disposed to view with disdain these so-called primitive methods of weaving, but a close study of them will show that they are very ingenious, and that they were the forerunners of many of our mechanical operations. We have no hesitation in saying that the thought required to evolve some of these ancient processes will compare favourably with that required for the evolution of some of our modern machinery. It is very often a more difficult matter to conceive a scheme for a certain purpose than to put it into practice. Once launched, a scheme, or the mechanism for it, is gradually improved until it approaches perfection, but those who have had the honour of making the last improvement as a finishing touch, or of producing the necessary articles upon an already more or less perfect machine, have not necessarily eclipsed the efforts of the pioneer. We should, therefore, have great respect for these early efforts, especially when one remembers that the means at the command of these early pioneers, and those who still practise similar weaving, were and are very much inferior to those which exist at the present time in this country. It has been truly said that "we may fall into error if we fix the intellectual capacity of a nation, a community, or an individual as low because we find that they practise, or he practises, something which we call, and perhaps correctly call, rude and primitive. Such a thing furnishes no proof of capacity; indeed, it does not furnish proof of want of culture."

CHAPTER III

WEAVING CLOTH ON SIMPLE FRAMES

THE CHIEF OPERATION OF WEAVING.

After the chain or warp has been prepared, the actual weaving commences. The chief operation in weaving, both in the hand-loom, and in the power-loom, is that of separating the threads of the warp into two layers, so that the needle, stick, bobbin, or shuttle which contains the weft may be passed between these two layers of warp threads. This operation is technically known as "shedding." Thus, suppose that all the threads of the warp are on the same level as indicated by the heavy line A in Fig. 21, then the operation of shedding is said to be performed when some of these threads are placed in a different plane to the remainder; whatever way this is done, an opening somewhat similar to that illustrated at B, C, or D, Fig. 21, would be made, and it is evident that the shuttle or other weft carrier could then be passed between the two sets of threads. The shed or opening for the second pick is usually made by a different selection of the threads from the solid group A, and so on, depending upon the number of different orders or picks which is required to form the design on the cloth.

For the simplest of all weaves—that is, the plain weave—there are only two picks in each repeat (see Fig. 6). For the first pick all the odd threads, say, are lifted, and the shuttle with the weft passed through the shed. For the second pick all the even threads would be lifted, and the shuttle again passed through, but this time the shuttle would travel in the opposite direction to that for the first pick. A different shed is thus formed for the two selections, and these two selections and operations are repeated for every pair of succeeding picks. In Fig. 6 it will be seen that each pair of picks is bracketed and marked A, showing that the weave or design repeats on two picks. This important part of the work will be discussed more fully later.

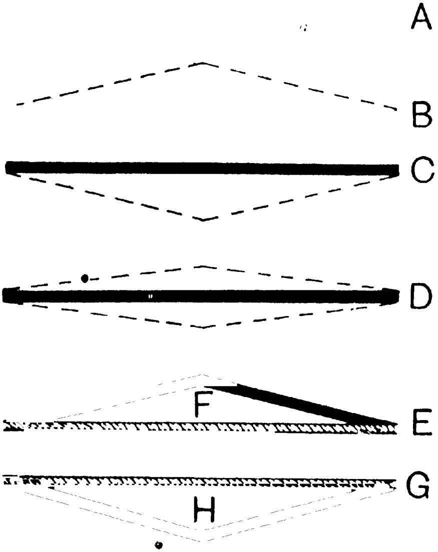


FIG. 21.

The same result could evidently be obtained if the threads in their normal position already formed two layers, as illustrated at E, Fig. 21, where half the number of threads, say the odd ones, 1, 3, 5, 7, etc., are represented in the highest position by the solid line, and the remaining half, the even-numbered threads, in the horizontal position as represented by the rope-like form. The shuttle or needle with the weft could then be passed through the opening or shed F. After this pick was inserted the threads represented by the heavy line could be pulled down to the lowest position, as shown at G, with the same rope-like set still in the horizontal position. The shuttle could then be passed through the opening H. Again, the two operations would be repeated as often as necessary to produce the desired length of cloth. With this arrangement it will be seen that one-half of the threads remain fixed or motionless in the horizontal position, while all the actual shedding is done by moving the threads which are marked in solid black.

The very fact of the operator being able to insert the weft between the two layers instead of having to select the place for the needle for every thread will obviously enable the work to be done at a quicker pace, provided that some means are adopted for effecting the two kinds of separation, as depicted at E and G in Fig. 21. There are several ways of making these selections other than those modern methods which are practised in our mills and factories.

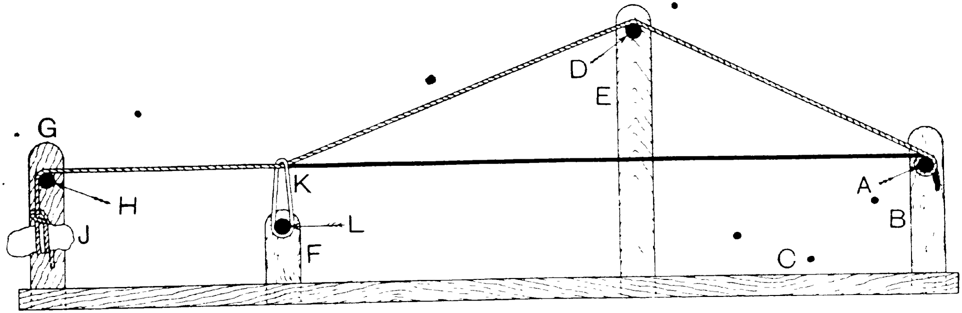
SIMPLE SHEDDING OPERATIONS.

Suppose, for example, that the operator had a series of warp threads one or two yards in length so that the ends of these threads could be wound round a rod or tied to the rod in a suitable way. Thus, the threads might be tied to the rod A, Fig. 22; the rod might be fixed to the upright bracket B, while the bracket B might be secured to the wooden base C. A second rod D, projecting from the longer bracket E, which is also fixed to the base C, is also provided. Two further brackets F and G are similarly fixed, and all the threads are then passed over the rod H and finally attached to a stone or weight J. A continuous length of cotton twine K is passed around the bar L in bracket F and over alternate threads of the warp, say the even-numbered ones indicated in rope-like form. The particular method adopted for the arrangement of the cords or loops K will be explained shortly. Finally, these even-numbered threads are passed over the rod D in the bracket E as shown. The rope-like threads would now be tight, whereas the solid black threads which are shown in a horizontal line in Fig. 22 would be comparatively slack.

Every pick of weft is introduced between the dark and light threads, and to the left of the loops K. Since the two sets of threads are approximately on the same level between the loops K and the bracket G, Fig. 22, it is obviously impossible to insert the weft between the two sets until a clear separation or opening is made. A clear shed may be made by placing one hand in the gap on the right between K and E, and pressing down the dark threads until a sufficiently wide < shaped gap obtains between the dark and light threads on the left of the loops K.

A similar separation might be made by using two round rods or perfectly flat rods with rounded corners, one rod above and one below the dark threads, as shown at M, Fig. 23. Rods so placed, and tied together at both ends, are termed "clasp rods." If, therefore, these rods, with the enclosed dark threads, are pressed down to the position indicated in Fig. 23, the shuttle or weft carrier could be passed between the two layers at N, and this pick of weft could be drawn forward by a comb until it is near the bracket G. This is done so that practically all the space between G and K may be utilised to form the shed. The shed thus formed corresponds exactly with that illustrated at G and H, Fig. 21, i.e. the dark threads

Fig 22



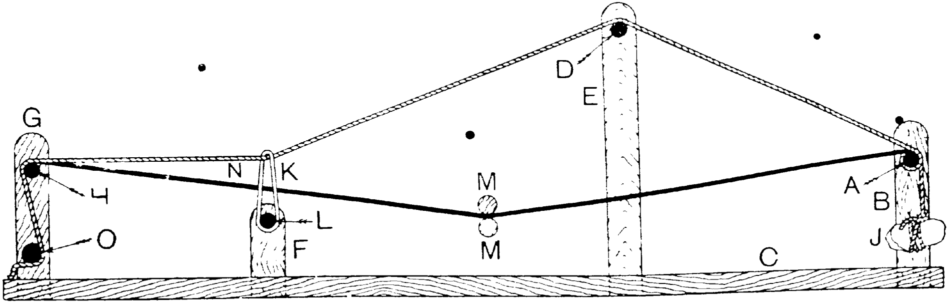


Fig 23

are under the light ones. The arrangement for holding the threads in Fig. 23 differs from that in Fig. 22. In Fig. 23 the stone or weight J is on the right at the opposite end to that in Fig. 22, and a second roller or beam O is provided on the left.

If now the rods M be raised to the position indicated in Fig. 24, it is clear that the dark threads will be carried above the light threads to the left of K, although they will still be under but close to the same light threads to the right of M. It is, of course, to the left of K where the weaving is done. This last operation enables a shed to be formed similar to that illustrated at E and F, Fig. 21. The weft is then inserted at P and drawn forward to join with the preceding pick, as explained in connection with Fig. 6.

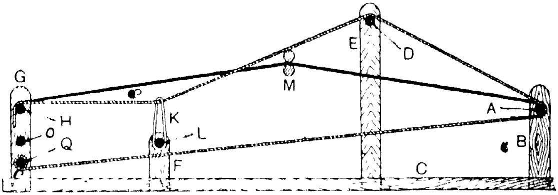
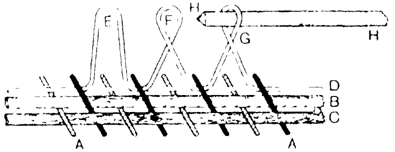


FIG. 24.

No other absolutely mechanical method of separating the two sets of threads in this frame is possible, and hence the two operations exemplified in Figs. 23 and 24 are repeated to weave the cloth. As the weaving proceeds, it is obvious that each succeeding pick would shorten the range between the points G and K. Hence, after a short length has been woven, it is necessary to draw both the woven cloth and the warp threads forward or to the left, and this may be done by either of the ways shown in Figs. 22 and 23. If an extra roller be inserted, as shown at Q, Fig. 24, both cloth and warp could be controlled from the operator's end of the frame; in this case the warp threads would be wound on the roller Q and the cloth on O.

The method of forming the loops and the method of weaving practised by the natives of many countries are illustrated in Figs. 25 to 28. It has already been mentioned that in a chain or warp a certain provision is made at both ends. This provision refers to what are known as the "beamer's lease" and the "drawer's lease." The latter is also often called the "weaver's lease," the "tying on lease," or the "thread by thread lease." For warps of a comparatively small number

FIG. 25.



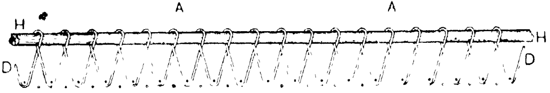


FIG. 26

of threads, such as those which are suitable for very narrow cloths, the "lease" may be the same at both ends. If so, it is the "thread by thread lease" which is made. Let us imagine that the eight threads A to A, Fig. 25, constitute the warp. If two wooden rods B and C, or two thick cords, are entered among the threads as indicated—really the two picks of the plain weave—they form the above drawer's, weaver's, or thread by thread lease. With this lease every thread is kept in its proper position. If a thread happened to break, there would clearly be two threads together or in the same order, and this condition, usually termed a "flat," or "sisters," would indicate to the weaver the place where the broken thread when retied should appear in the warp. This is the only purpose which the lease plays in such weaving. For the simpler kinds of cloth in power-loom weaving the lease answers an entirely different purpose in addition to that mentioned above. (See "cover" and "Reed Marking" in *Jute and Linen Weaving*, by T. Woodhouse and T. Milne.)

The threads shown at A, Fig. 25, may be taken to represent that part only where the loops are to be formed, but it will be understood that the two ends of the warp will be attached to suitable rods or the like in order to keep all the threads in tension. A length of strong cotton twist twine D, say three or four ply and comparatively thin not more than $\frac{1}{12}$ in. in thickness is inserted amongst the warp threads in precisely the same order as the rod B. The end of this cord, where the operation of forming the loops is to commence, is tied to any suitable object so that it will not be withdrawn accidentally. Three stages in the formation of each loop are illustrated at E, F, and G.

1. The cotton cord, which passes over the third thread from the left, is raised about 2 in., when it will appear as indicated at E. The first thread has been left untouched to show how all the light threads would appear before the operation of forming the loops commenced.

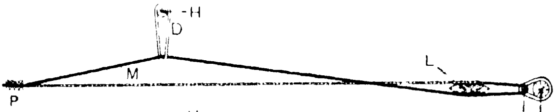
2. While in the above position E, the upper part is turned half round, 180 deg., as shown by the part F in the next light thread.

3. The loop is then turned a little more in the same direction, as at G, to admit of the rod H being inserted.

The section of cotton cord which passes over every second thread of warp is treated in the same way and in regular order. The dotted lines at the base of each loop E, F, and G indicate the original position of these parts of the cotton cord. When the operation is finished, the effect will be somewhat similar to that illustrated in Fig. 26, which consists of 19 such loops, and shows that the 19 dark threads only are under the influence of the loops. The arrangement differs from that shown in Figs. 22 to 24 in that the rod for the loops is at the top instead of at the bottom.

The warp is stretched as usual, the right-hand end in Figs. 27 and 28 held as shown by means of a small rod J and a thick rod K. The other end of the warp, which would also be held, illustrates two different structures of cloth, although both are woven with

Fig. 27



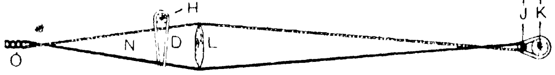


Fig. 28

the plain weave. The same operations of weaving are essential for both. A lath L is used to help in the formation of the shed.

When it is required to raise the even-numbered or dark threads, the lath L is placed far back, as shown in Fig. 27, the rod H raised, and the weft inserted between the two layers at M. This pick of weft is drawn forward either by a comb or by a similar lath to L. For the second operation the lath L is brought close up to the loops D and placed on its edge as demonstrated in Fig. 28. This causes the dark and light threads to alter their positions to that illustrated, and a second pick of weft is inserted between at N. This pick in turn is brought into close proximity with the preceding pick, and so on for every pair of similar picks.

In Fig. 28 four picks of weft are shown in position at O, while in Fig. 27, in the same horizontal space, eight picks are shown at P. It will be seen that in Fig. 28 the weft at O is completely covered by the dark and light threads, and these two series would give dark and light stripes across the cloth from selvage to selvage and at both sides of the cloth. The operation of weaving, however, with such a large number of warp threads is rather difficult. On the other hand, the weft at P, Fig. 27, covers the two sets of warp threads. (In practice it would be unnecessary to have two colours of warp threads when all the threads are covered by the weft.)

In the section illustrated at P, Fig. 27, it is assumed that two colours of weft are used, medium and light, and that the medium-coloured ones are above the warp threads. In the adjoining section that is, one thread farther into the cloth - the two colours of weft will have changed places, the light ones being at the top. With this arrangement, very narrow stripes in the opposite direction, i.e. in the length of the cloth, are formed. This type of stripe is often called a "hairline" stripe, or a "pin" stripe. The parts O and P, Figs. 28 and 27, represent respectively two of the conditions of "setting" already referred to, e.g.:

O. Where there is a maximum number of warp threads and a minimum number of weft picks;

P. Where there is a minimum number of warp threads and a maximum number of weft picks.

The intermediate stage is represented by the cloths in Figs. 13, 15, and 16. The structures may vary gradually between the two extremes, and in practice there is quite a host of different settings, termed generally "setts" and "porters," preceded by numbers which indicate the relative fineness or coarseness of the cloth in the way of the warp. The relative fineness or coarseness in the other direction is distinguished by the number of shots or picks per inch, or picks per "glass" if such an instrument is used for counting (see *Healds and Reeds for Weaving*).

The illustrations in Figs. 25 and 26 have been made from one of these crude frames in which the so-called "heald-rod" or principal shedding apparatus is provided, as already mentioned, with looped cotton twine. It is quite likely, however, that such suitable material would be unobtainable in early periods, and even yet not available in many districts remote from textile centres. As a matter of fact, the heald-rod in use at the present day, in some countries, is furnished with dry grasses which perform identical functions as the above-mentioned cotton loops D on the rod H. A photographical reproduction of a loom provided with such a heald-rod appears in Fig. 29. The view shows the underside of the loom, and has been taken from the collection in the museum of the Albert Institute, Dundee.

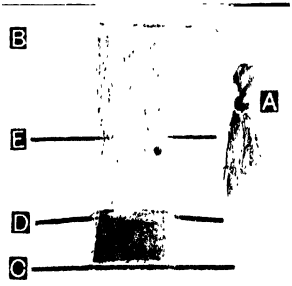


Fig. 29.

It is termed a Backwalo loom, and was brought from Upper Congo, Africa. The warp is made entirely of dried grasses, each blade of grass being split up into several parts to form the desired size, width, or thickness of each part or thread. A bunch of these native grasses is shown detached at A on the right.

The weft is the same kind of material, and each length of grass suffices for a few shots or picks of weft. In this way a kind of rough selvage is formed. The length of the warp in this case is obviously determined by the length of the grasses; these, in the case under notice, are about 3 ft. 6 in. long and are wound on the rod B. The fabric is absolutely plain and about 10 in. wide, and there are 22 threads per inch of warp and 22 picks per inch of weft. In the loom there are

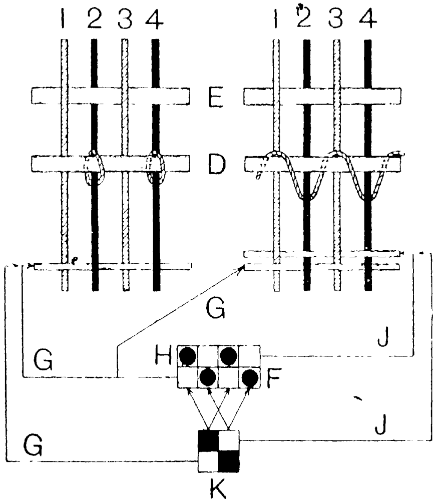


FIG. 30.

the usual end rods B and C, while D represents the heald-rod and E corresponds to the flat rod L in Figs. 27 and 28.

Four threads of the warp, 1, 2, 3, and 4, are shown in each of the two main views in Fig. 30. In the left-hand view the loops on the heald-rod D are shown diagrammatically, but obviously attached to the heald-rod; while in the right-hand figure the corresponding loops are illustrated somewhat as they actually are on the rod D, Fig. 29. If, as explained before, the heald-rod D, Fig. 30, is lifted, and the rod E forced back if necessary, the shed formed would be 1 down, 1 up, 1 down, 1 up, as indicated by the lower horizontal line F in the design on 4 threads and 2 picks, and also by the single pick of weft G which is inserted, and which is represented by the line of marks F.

If, now, the rod E be brought forward, and turned on its edge if it be a flat rod, threads 2 and 4 will be forced to the bottom of the loops on the heald-rod D, while threads 1 and 3 will be raised between the loops according to the upper horizontal line H in the design, and the second pick J can be inserted. The depth of the shed is determined by the depth of the loops on the heald-rod D. In the formation of both the sheds it might be necessary to supplement the work of the rods by the fingers in order to make a clean or clear opening for the insertion of the weft. The plain pattern, or plain cloth, in Fig. 29 is produced by the successive and alternate movements of these two rods D and E as described, and by the necessary number of loops on the heald-rod D for the even-numbered threads of the warp. The four small squares at K (Fig. 30) again represent the unit weave, although it starts at a different square from that illustrated in Fig. 6.

A photographical reproduction of the upper side of a somewhat similar, but much more elaborate, cloth is that illustrated in Fig. 31. Here, again, the warp is made entirely of native-grown grasses which are split up as before into a suitable number of strips to form the equivalent of warp threads. The full length of the warp, 2 ft. 9 in., is clearly visible in this case. The beginning of the warp is tied in bunches to similar material, which in turn is tied to the back rod J. The actual ribbon-like form of the grasses is seen at the other end where the weaving commenced, and where the grasses are tied to the rod K. Four or five thin sticks L are first woven in plain order to draw all the threads to approximately the same tension, and to form a kind of stable straight line against which the actual weft is pushed. This cloth is of a figured character, contains 52 threads per inch and 24 picks per inch, and is 31 in. wide. It will be observed that there are no selvages; each pick of weft is distinct from the rest, and the ends of all project at both sides, as is shown clearly in the illustration. This loom is also in the Dundee collection.

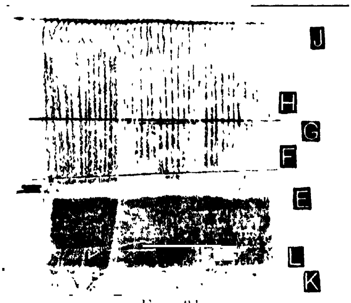


Fig. 31.

A modification of the mounting or of heald-rod and other rods is essential when any elaboration of the pattern is desired, and in the example illustrated in Fig. 31, near the rod K and the thin sticks L, the pattern is obviously seen to be formed of prominent vertical stripes alternating with diamond figures—all the figuring being developed by the weft. The remaining part, or ground of the cloth, is perfectly plain as in the cloth in Fig. 29.

As seen from Fig. 31, four distinct rods, in addition to the rods J, K, and L, were employed in the weaving of the pattern. Two of these rods, marked E and F, are heald-rods. Perhaps the best way to describe the method of working will be to illustrate separately the actual designs which form the stripe and the diamond patterns respectively and afterwards to show how the warp threads are inserted amongst the rods G and H, and in the loops of the heald-rods E and F, and finally to show how all the rods are manipulated to achieve the results illustrated on the cloth.

It has already been mentioned that marks on the design paper may be taken arbitrarily to represent either warp or weft on the surface of the cloth. Up to the present, the marks used represent warp on the surface. This method of marking is technically described by the words "marks rise." The other method of marking will, on the contrary, be distinguished by the words "marks fall," which obviously mean that the marks represent the weft yarns on the surface, or, at least, the weft over the warp. The effect produced in the cloth is often quite different from what one might expect from the marking, but the designs indicate absolutely the order in which the yarns interweave.

Designs A and B (Fig. 32) have been made so that the long rows or "floats" of solid black marks represent weft which, at certain places, passes over five successive threads. Hence, in designs A and B, marks fall. All the weft is exactly of the same kind and thickness of grass, hence the different effects on the cloth are produced by changing the method of interweaving the warp with the weft, and in the order illustrated in Fig. 32. Those picks which show the actual ornament on the surface of the cloth are shown in solid black, while, on the other hand, those picks which form the plain cloth, or groundwork of the fabric, are shown in crosses. The effect produced on the cloth by the design A is the stripe pattern, while the effect produced by the design B is the diamond pattern often termed the "drop" pattern.

The designs A and B made on the principle of "marks fall" certainly show up the weft pattern well, but it will be much more convenient to consider marks to rise when examining the movements of the heald-rods and other rods. Consequently, designs C and D, Fig. 32, have been prepared, in which the

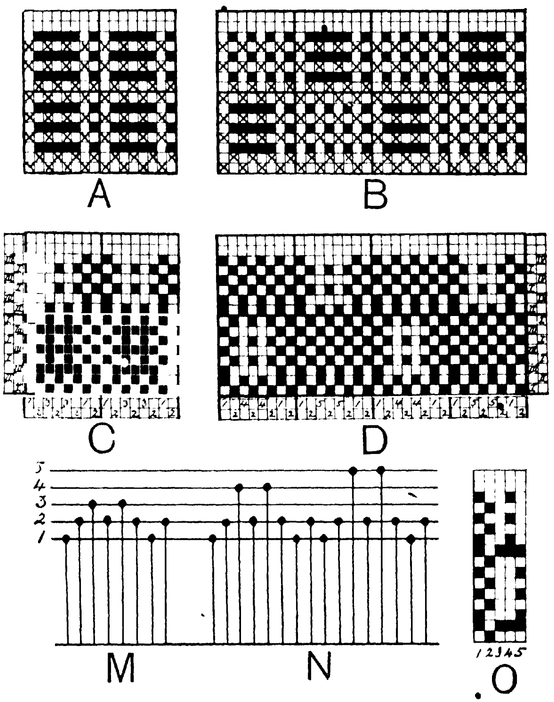
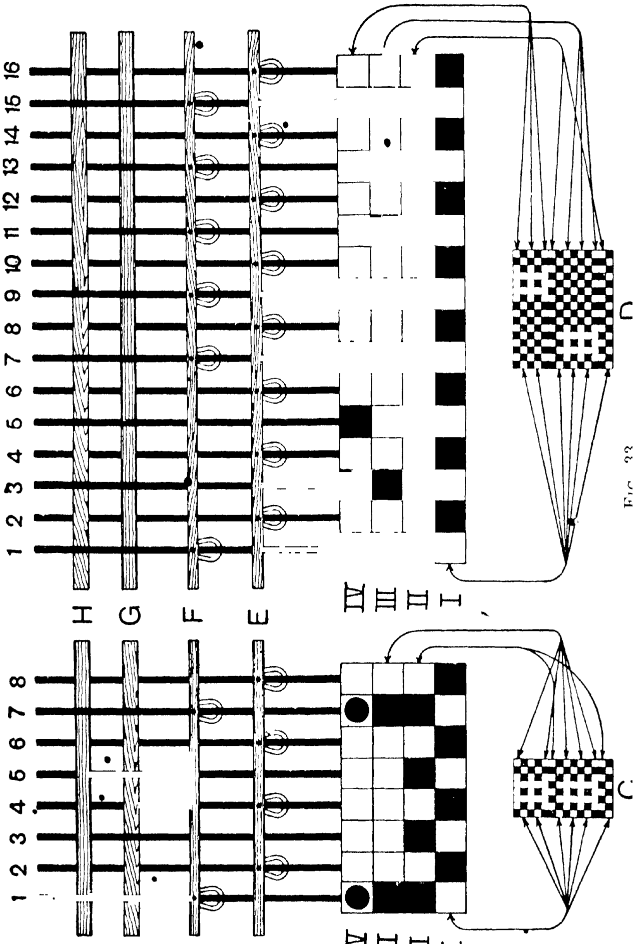


Fig. 32.

blanks or unmarked squares replace marks of all kinds in the designs A and B, and, consequently, the solid marks in designs C and D replace all unmarked squares in designs A and B.

If design C be examined closely it will be found that there are only three different orders in the horizontal rows. Thus, all the rows marked I are identical, but different from the rows marked II, although all those marked II are alike; finally, all those marked III are of the same order, but different from those marked I and II. This numbering, or grouping, of similar rows in the horizontal direction has no actual practical importance, although it corresponds somewhat to the grouping or collection of similar vertical rows or threads, as explained in connection with design A, Fig. 8. For example, all vertical rows which contain marks and blanks in the same order receive the same number This is shown clearly by the ordinary numbers under the threads in designs C and D, each of which is twice repeated. If the horizontal rows of design D be examined closely, it will be found that there are four different orders and as indicated by the Roman numerals I, II, III, and IV on the right. It will also be seen that, whereas the design C is complete on seven picks (two units or fourteen picks are illustrated), the design D requires all the fourteen picks for one unit. Moreover, since these two different designs are developed side by side in the cloth in Fig. 31, and hence by the same picks of weft, the order of arranging the threads amongst the four rods E, F, G, and H must be such that the corresponding picks 1 to 14 in both designs can be developed correctly and simultaneously.

The various sections in Fig. 33, which indicate that two of the rods, E and F, are heald-rods, show how this particular design may be woven. It need hardly be said that a considerable amount of care would be necessary; that the fingers would probably have to


1
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D
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2
3
4
5
6
7
8
H
G
F
E
IV
III
II
I
C

Fig. 33

work deftly amongst the threads in order to aid the rods in the formation of the cloth; and that the work as a whole would be tedious and slow. In Figs. 31, 32, and 33 similar parts are lettered and numbered in the same way.

One unit in the way of the warp from each of the designs C and D, Fig. 32, has been reproduced in Fig. 33, but, since several picks are of the same character, it is obviously only necessary to describe the working of the rods for the different orders, i.e. I, II, and III for the diagram on the left in Fig. 33, and I, II, III, and IV for the diagram on the right. The marks on the fourth line of the working design on the left are in circles, because they are identical with the third line, and therefore unnecessary except in so far as having to work in this order in conjunction with the fourth line of the working design on the right. The connection between the horizontal lines of the complete designs C and D, Fig. 33, and the similar single lines of the working designs immediately above is clearly shown by the lines which join identical markings. Hence, for picks 1, 4, 6, 8, 11, and 13 in both designs C and D, the shedding must be the same as line I in the working designs.

If the main or front heald-rod E be raised with rods G and H pushed back, if necessary, the loops would lift all the even-numbered threads in both diagrams. All the threads are numbered consecutively in each diagram at the top. For the opposite plain pick, II in the working designs, and picks 2 and 9 in designs C and D, it is necessary to bring rod G forward, to turn it on edge if it is a flat one, and thus raise all the odd-numbered threads and depress all the even-numbered threads in both diagrams. As mentioned before, the extent to which the even-numbered threads can be depressed is limited by the depth of the loops in the heald-rod E.

For picks 3, 5, and 7 of the designs C and D, or pick III of the working designs, the second heald-rod F must be lifted, and all the even-numbered threads forced down by the rod G. (Note that the arrangement of the loops on the heald-rod F in the first half of the right-hand diagram differs from the arrangement of the loops in the second half of the same diagram.) For picks 10, 12, and 14 of designs C and D, or pick IV of the working designs, it is necessary to slide the rod H in front of the rod G this is possible—and to turn the rod H on its edge, if it is a flat one. This operation will act as under:

In left-hand diagram threads 2, 3, 4, 5, and 6, as well as thread 8, will be depressed so that the weft could pass over.

In right-hand diagram threads 2, 4, 6, and 8, and threads 10, 11, 12, 13, and 14, as well as thread 16, will be depressed, and the float over five threads would appear only in the second half of the right-hand diagram, as demanded by the design D.

It is at once an ingenious and elegant arrangement of simple parts to produce a comparatively fancy design. In modern looms the production of the two designs C and D simultaneously by the same picks of weft would require five leaves. The threads of the warp for the design C might be drawn through the heddle eyes as indicated by the draft M, Fig. 32; those for the design D might be drawn as shown in the draft N one unit only of each draft being shown in the figure and the group of five leaves operated as indicated at O. The general name for O is the "weaving plan," but it is also known as the "pegging plan" and the "card plan," while similar plans for treadle-looms are known as "treading plans," or simply the "tramp." Since half of the threads in both designs weave in the same order, it might be better, in practice, to place these threads on the first leaf instead of on the second leaf, and place those which are at present on the first leaf on to the second leaf. It is a common practice to let the front leaf carry the most, if a difference does obtain as in the present examples.

Fig. 34 illustrates three different and yet similar types of fabrics from Upper Congo, termed Mongo native cloth, and which have probably been woven in looms somewhat similar to that illustrated in Fig. 31. These fabrics have come from the same country, Upper Congo, and are termed Kasai cloth. Both warp and weft in all three examples are of the same type of dried grasses, but half the weft—every alternate pick—is dyed to a dark red colour. The ends of the weft extend for a few inches beyond each edge of the cloth, and thus form fringes which constitute an attractive feature of the textures.

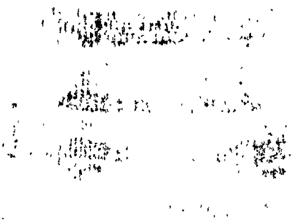

FIG. 34

It need hardly be said that, although the upper pattern in Fig. 34 might be woven on much the same principle as that illustrated in Fig. 31, the two lower patterns could not be woven on this principle. Nevertheless, by a somewhat similar operation of weaving for the vertical stripes and for the ground, and a system of hand selection for the zigzag or vertical herring-bone patterns, such cloths might, with difficulty, be woven in such looms. It must be remembered that, as a rule, time is no object in such weaving. We shall have occasion to illustrate later, in conjunction with looms of an entirely different

Fig. 35

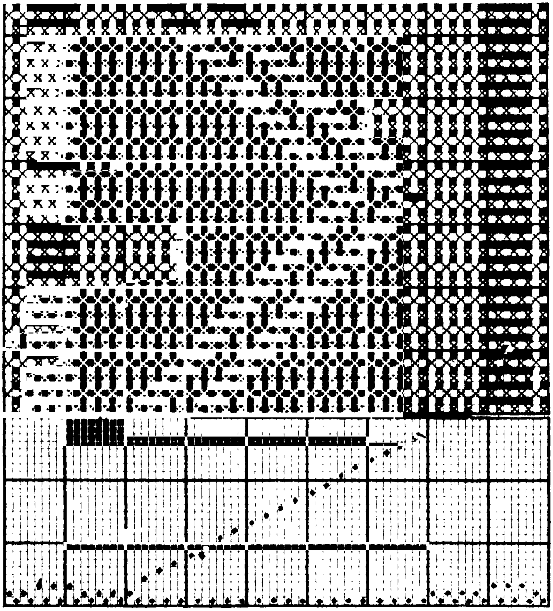

Fig. 36.

construction, this double process of weaving and hand selection.

The modern method of weaving the two lower patterns in Fig. 34, either in hand- or power-looms, would be by means of a dobby loom or a jacquard loom. The design fo. the bottom pattern in Fig. 34, or, rather, for one section of it the central stripe is illustrated on 72 threads and 52 picks in Fig. 35. If it were woven in a dobby by means of leaves, the 72 threads of the warp would be drawn through 22 leaves of healds and in the order illustrated in Fig. 36. This is termed the "draft," or the order of drawing the threads through the lowest possible number of leaves. In this particular case there are 22 horizontal rows of squares and these rows represent the 22 leaves; the dots indicate the leaves through which the corresponding threads are drawn. In Fig. 36 all the even-numbered threads from Fig. 35, which weave or interlace with the weft in precisely the same order, are drawn through the eyes of the first leaf. Although the number of leaves shown, 22, is the minimum number, it might be necessary in practice to use two leaves instead of one leaf for the even-numbered threads because of the large number. The weaving plan, or the order of operating the 22 leaves

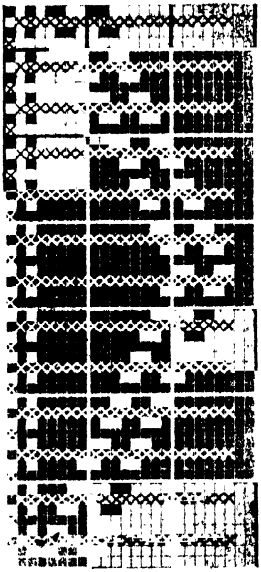

FIG. 37.

in the loom, is shown by the 22 vertical rows of small squares in Fig. 37. All the remaining threads in the lower pattern in Fig. 34 could be woven by the same 22 leaves, and the proper arrangement or draft of the threads, and, naturally, no alteration would be required in the weaving plan shown in Fig. 37.

The introduction of two colours of weft, as exemplified in Fig. 34, obviously opens up a new field for the embellishment of a fabric. And when two or more colours of weft are used it does not necessarily follow that the scheme of weaving or interlacing should be as complex as that described and illustrated in connection with Figs. 31 to 37. As a matter of fact, the simplest arrangement of these frames suffices for the development of figures when various colours of weft are utilised. Thus, Figs. 38 and 39 illustrate the two sides of a reversible fabric which was woven in a small frame; indeed, the method of forming the heald-rod in Fig. 25 was taken from this miniature loom. The ornament is directed to the left in Fig. 38 and to the right in Fig. 39.

The fabric, which is about 12 in. wide, is composed of a white cotton warp, and four or five different colours of wool weft. The black weft and the red weft show the same colour in the reproduction, and this accounts for the wide dark stripe. In Fig. 38 the flat rod has its broad faces parallel to the warp threads, while in Fig. 39 the same flat rod is on its edge for the purpose already described. The upper detached figure on the left in each view is the beating-up stick, while the lower stick with the prongs is used as a final beating-up instrument.

The development of the quadrilateral figures on this fabric is due entirely to the way in which the various coloured wefts are introduced, and to the place where these wefts are inserted. The weave is absolutely plain, i.e. the structure is identical with that illustrated in Figs. 6, 7, and 29, but the relative number of

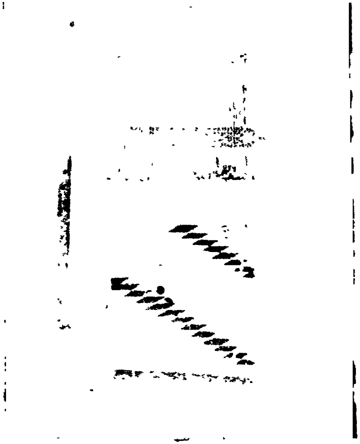

FIG 38

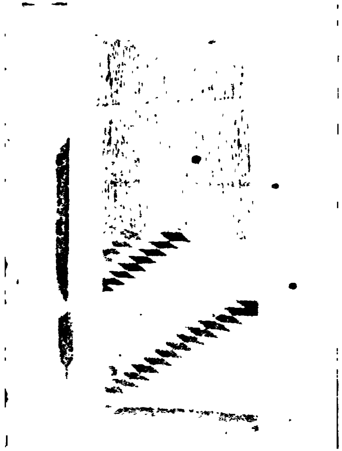

FIG. 39

warp threads to weft picks is according to Condition II (p. 15). In other words, there are several more picks per inch of thick weft than threads per inch of thin warp, and this results in the warp threads being hidden from both sides of the cloth, and as exemplified in Fig. 13.

The method of construction is to have four or five quills or thin bobbins, or else small pieces of cardboard or the like, upon which the different colours of weft are wound; each cardboard should be supplied with its own particular colour. Then, when the first shed is formed by lifting up the heald-rod, one cardboard with colour No. 1 is introduced between the threads of the warp for a distance equal to the length of the parallelogram, say about 1½ in. wide, and then withdrawn. With the same shed still open, the next cardboard containing colour No. 2 is introduced for the adjoining parallelogram of 1½ in. width, and so on until the desired horizontal colour scheme is completed. In Figs. 38 and 39 there are about seven sections in the width. For the second pick the flat rod is placed on its edge, and the same colours of weft are returned in the corresponding sections. The coloured wefts are introduced in the same order for each pair of picks until the depth or length of the parallelograms has been woven, but each time the colour sections commence at a point two threads to the right in Fig. 38, or two threads to the left in Fig. 39. The various coloured sections thus form twills for, say, half an inch of cloth, after which each colour moves a full section as indicated to form another parallelogram. Each individual parallelogram, say, in Fig. 38, moves or, as is technically termed, twills to the right, whereas each line of complete self-coloured quadrilateral figures forms a twill to the left. It is this left twill of figures which constitutes the prominent direction of the figures in Fig. 38, while the corresponding effect in Fig. 39 is to the right.

Such figuring as that demonstrated in Figs. 38 and 39, unique in itself as a figure, is the basis of all similar ornamentation by this method of weaving, and by this particular quantitative distribution of warp and weft.

In many cases the two end supporting rods of the loom are made fast and at the proper distance apart by the use of trees and props of different kinds as is illustrated in the two views in Fig. 40. These views were taken from picture post cards, and demonstrate the weaving of fancy rugs by the method just described.* It will be seen that part of the ornament twills in both directions on the same surface, while other parts are developed in horizontal and vertical figures. In both cases the ornament, although neatly arranged, is of simple geometrical figures, but it naturally loses much of its beauty in virtue of the various colours being represented by black, white, and different depths of grey.

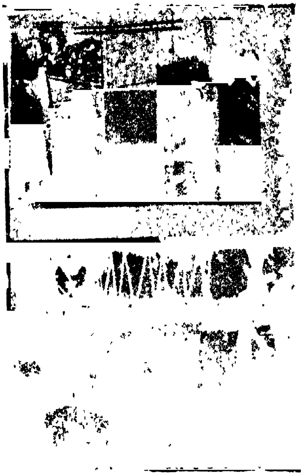

FIG. 40.

Fig. 41 is an interesting view of the interior of a Mexican cottage in which the weaving of a comparatively wide fabric is in operation. The cloth is

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* The publisher is unknown to the author, otherwise the firm would have been mentioned. No thought of publication was considered when the photographs were taken.

obviously a striped one, and in this instance occupies the top position. Bundles of grasses appear in different parts of the room, those near the roof resembling closely flax stalks with the seed-bolls intact.

A combination of the simple and complex methods of weaving, with a self-coloured warp and several colours of weft, is illustrated in Fig. 12. The framework of this loom is somewhat similar to that in Fig. 10, but the warp in the present case is made to go round the two beams A and B, so that the length of the fabric, plus the fringes, can be made approximately equal to twice the length of the stretch indicated from A to B. The necessary tension to the endless warp is obtained by drawing tight the cords C, and fixing them securely round the beam D. The ends of the

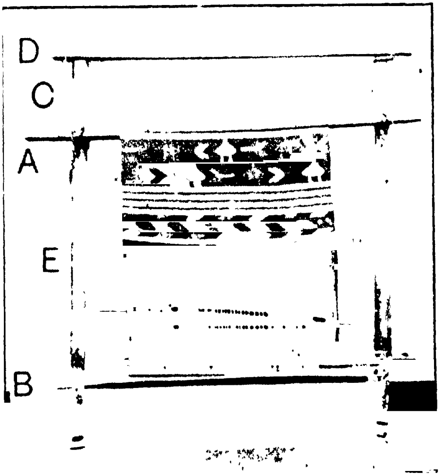


FIG. 12.

two vertical beams E pass through slots in the beams B and D, the end of the beam E being tapered to admit of a stable condition.

In Fig 42 the heald-rod and several other rods are quite near the beam B the cloth and warp having been pulled round in order to obtain different views of the pattern. In Fig. 43, which is another view of the same loom, the warp and cloth have been moved into the positions which the parts would occupy while the operation of weaving was proceeding.

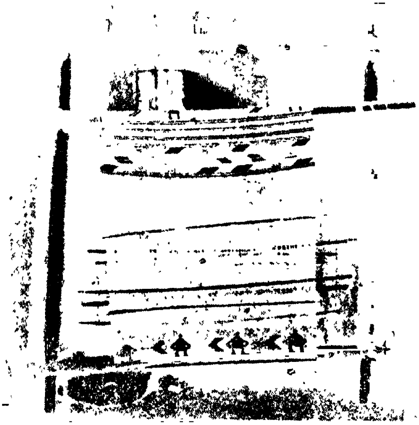


FIG. 43.

Several of the rods had probably been accidentally withdrawn and inserted again, more or less haphazard, some time before Fig. 42 was made, but before Fig. 43 was taken some of the more essential rods were inserted among the warp threads in the proper order and then all tied together as shown to prevent further withdrawal. The top rod in Fig. 43 is really the shuttle, and was inserted loosely, as demonstrated, so that it could be photographed with the loom. Both ends of the shuttle are forked, and hence a comparatively long length of fine weft could be wound on, or, rather, wrapped on.

The next two rods appear to be in the wrong order, but since the pattern shown can be woven without these two, their presence might be neglected for our purpose. The fourth rod down is provided all along its upper surface with oblique slots, which have been burnt out with a hot wire of some kind. Its structure is very similar to, but on a much wider scale and longer than, the illustration in Fig. 44. This rod has evidently been used as a kind of "temple," the use of which is to keep the threads out to the width during the operation of weaving, and so minimise the number of warp breakages near the selvages of the cloth.

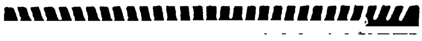


FIG. 44

(For various kinds of modern temples used both in hand-looms and power-looms, see *Jute and Linen Weaving*. *Mechanism*, 2nd edition, pp. 518 to 526.)

The bottom rod in Fig. 43, often termed the spatha, is for "beating up" or forcing each shot of weft successively into close proximity with the last one inserted in the cloth. The second rod from the cloth is the "heald-rod," which is made more carefully, and on a better principle than that illustrated in any of the foregoing examples. The loops pass round the heald-rod very similarly to the others illustrated, but they also pass round a second but thinner rod or cord immediately above the heald-rod; the latter thus takes the place of, and resembles greatly, the "leading cord" in modern healds (see the author's work on *Reeds and Healds for Weaving*.) The arrangement of the cords in the heald-rod in Fig. 43 is shown in Fig. 46, while the method of forming the three different sheds, together with a view of all the rods, appears in Fig. 45. The three distinct sheds are, of course, represented by the three horizontal rows of squares I, II, and III.

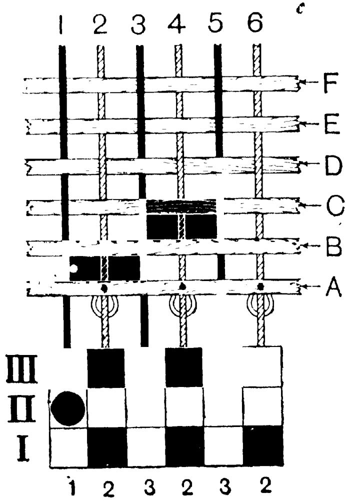


FIG. 45.

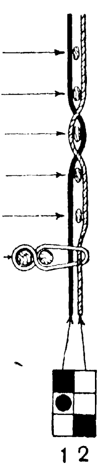


FIG. 46.

The first rod A in Fig. 45 is the heald-rod, the loops of which control all the even-numbered threads. The second rod B passes, as shown, under one thread and over the next five, and serves the purpose of a second heald-rod: this order, under one and over five, is preserved throughout, and hence the single unit illustrated is quite sufficient for demonstration purposes. Rods C and D form an ordinary lease amongst the threads, while the two rods E and F are inserted in exactly the same way as rod C—hence the above remark neglecting their presence.

From the preceding examples it will be clear that when the heald-rod A is raised, a shed will be formed with all the even-numbered threads in the upper layer and all the odd-numbered threads in the lower layer; the shuttle or weft carrier is passed between these two layers to form one of the plain picks of the dark ground. After the rod A is returned to its normal position, rod B is lifted, or rather turned on its edge; it will raise the first thread and depress the next five, and will operate every group of six across the warp in the same manner. This opening is required for some, and, indeed, all, of the figure picks marked II in Fig. 45, and all these figure picks are much lighter in colour than the ground weft or the warp. The introduction of this figure weft from selvage to selvage would leave an effect in the cloth corresponding to one of the light horizontal stripes in Figs. 42 and 43—those stripes which bound the rows of detached animate and inanimate figures. Finally, for the order represented by the horizontal row III in Fig. 45, rod B must be forced behind rod C, and the latter brought close up and turned on its edge; this will cause all even-numbered threads to be pressed to the bottom of the loops of heald-rod A, and all odd-numbered threads to be raised, thus forming the next plain pick of the ground, but, of course, opposite to that marked I, and through which another pick of the dark-ground weft is inserted.

The three picks shown at I, II, and III are the only ones which are made entirely by the mechanical movement of the rods, that is, without the joint action of selection by the fingers. It is obvious, however, that the majority of the figure picks in Figs. 42 and 43 must appear on the surface of the cloth only when required to form the ornament at the various parts.

Moreover, it is equally evident that there are a few different colours of weft required to develop the ornamentation. As a matter of fact, while all the ground weft is dark blue, the figuring wefts include the following colours: pale green, terra cotta, yellow, and white, and each line of weft is composed of six distinct threads; in other words, all the figuring weft is what is known technically as six-fold or six-ply yarn.

Fig. 47 has been prepared partly to show the structure of the fabric, and partly to enable us to describe the dual process of weaving and hand selection. The design in Fig. 47 is made for "marks to fall" in order that the effect produced by the coloured or figuring wefts can be indicated to the best advantage, and hence the design differs from the working design I, II, and III in Fig. 45, where all marks represent threads to rise. It will thus be seen that the 18 small squares in the above working design are represented by the corresponding 18 smaller squares in the bottom left-hand corner of Fig. 47, when the effect resulting from the changing of marks is considered.

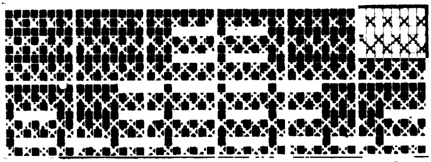


FIG. 47.

The three operations described with reference to picks I, II, and III, Fig. 45, give, as shown, two plain picks, one on each side of a figure pick. Since the latter goes under one thread and over five all the way across, it may be considered as being represented by the second pick or horizontal row of small squares in Fig. 47. The second figure pick in this design is, of course, actually the fifth pick when the plain picks are counted, and it is evident that the coloured weft on this pick is required to miss two groups one near each end as indicated by the two detached rows of successive blank squares. The third figuring pick, the eighth pick of the design, should miss four groups as shown by the still longer rows of successive blank squares; while the fourth and fifth figuring picks, the eleventh and fourteenth actual picks in the design, miss all groups except the two middle ones.

It is for such variations as these that the mechanical operations have to be aided by a selective hand process. In addition, it will be seen from the different depths of tone in Figs. 42 and 43 that in the same horizontal row of detached ornamentation one figure might be developed in pale green, another in pink, and yet others in yellow and white, while none of these colours must be displayed between the various figures.

Special weft carriers, to wit, small pieces of cardboard, might be used, or even a small ball of each colour of weft might be wound, and each colour is passed through that portion of the full-width shed which corresponds to the width of the particular ornament to be made by that colour. The extent to which each and all of the figuring wefts is displayed varies, obviously, from line to line, or nearly so, as exemplified on a small scale in Fig. 47.

Hence, after the weaver has lifted the rod B, Fig. 45, and thus raised every sixth thread in the warp, it is kept there until each coloured weft has been passed through the shed according to the width desired. Thus, the pink weft might be passed under the four middle groups on the fifth pick in Fig. 47; the next group on each side is missed because the squares are blank; while the single group on each side might be the edges of two other figures which should have, say, terra cotta and yellow respectively. This selective process would be continued until all the necessary lengths or, rather, widths of the different ornaments had been supplied with the proper colours for that particular line of the design. Then, after two plain picks have been inserted, the same set of colouring wefts, one for each individual figure, are introduced across different widths when the rod B is lifted for this row, or perhaps the same width in some cases, but this time each weft carrier passes in the opposite direction. Thus:

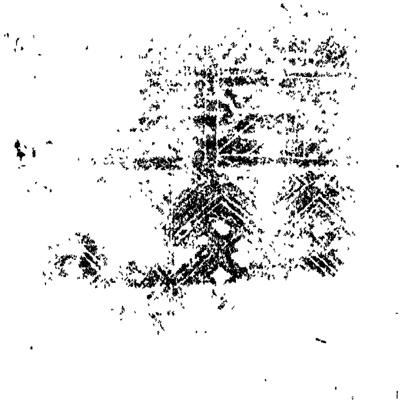


FIG. 48.

For the first figuring pick, all coloured wefts go from left to right.

For the second figuring pick, all coloured wefts go from right to left.

This order is repeated for every pair of figuring picks, so that each time the weft is caused to move in the opposite direction it is bound to the cloth in a manner somewhat similar to that of the yarns in modern lappet and swivel fabrics, a description and illustrations of which appear on pages 476 to 496 in *Textile Design: Pure and Applied*, by T. Woodhouse and T. Milne. The width of the cloth in Fig. 43 is 33 in.; there are 54 threads per inch in the warp, and 24 ground picks per inch.

From the above description it will be gathered that practically any type of bold ornament can be produced by the dual operation, but, since all the figuring wefts move in groups of six, the outline of every detached figure will naturally be in steps, the width of which depends upon the number of threads per inch in the warp. If a finer outline were required, the rod B, Fig. 45, could be made to pass under one and over three, when a corresponding reduction in the float would obtain, but, at the same time, the ornament would not be so fully pronounced as with a float of five.

As a final example of weaving produced in the above types of loom, we introduce Fig. 48. This is termed Kasai cloth from Upper Congo, and the groundwork of the fabric is again constructed of dried grasses. The diamond and other forms of ornamentation are due to handwork, and are in mid-relief. The foundation lines of the diamonds, squares, and diagonals are formed ingeniously by placing comparatively heavy cords at the desired angles, and, as the weaving proceeds, binding these cords to the cloth with the successive ground picks at the proper places according to the configuration of the geometrical outline.

The larger areas are in high relief, and are developed by pine-apple fibre by a process of weaving known as pile, plush, or velvet weaving, particulars of which and several illustrations will be found on pages 36 to 440 of the above work on *Textile Design: Pur and Applied*.

Fig. 49 illustrates an Armenian girl weaving on on

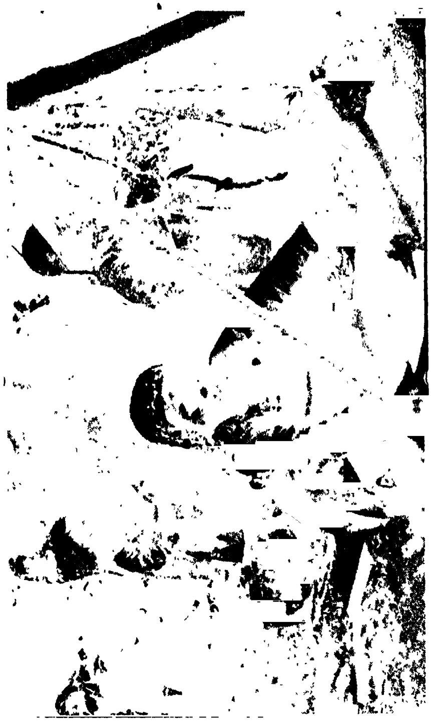


FIG. 49.

of the simplest types of loom which are so common i many of these eastern countries. The cloth is quit plain and made from cotton yarns. One "heald rod" only is used, and this is seen quite clearl above the warp threads to the right of the weaver and supported from the tripod by two strong cords. The girl is just in the act of beating up the last shot of weft with a flat piece of wood, which, as already mentioned, performs one only of the functions of a modern reed.

The warp for the loom illustrated in Fig. 49 is practically circular, and thus resembles that in Figs. 42 and 43. But whereas the warp in the two latter views was probably intended to be woven in the vertical position, the one in Fig. 49 is obviously arranged horizontally as in modern looms. One of the stout supports for the warp and cloth is shown to the left in Fig. 49, behind the weaver. The cloth is seen round this post, and will be pulled further round as the weaving proceeds, until ultimately it comes over the back post or rail and towards the "heald-rod" until weaving is no longer possible.

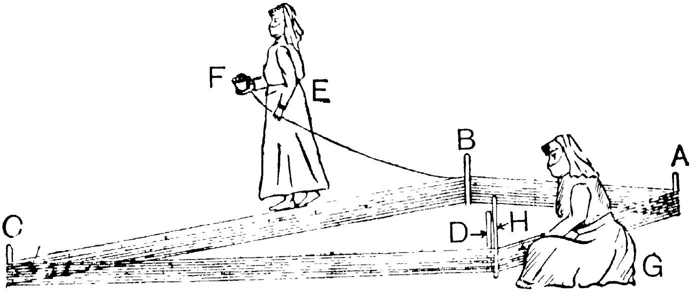


FIG. 50.

Some of the Persian nomads weave their carpets in looms very similar to that in Fig. 49, because they can be easily bundled or rolled up and transported from place to place.

Endless warps such as that mentioned are made in some countries by the method illustrated in Fig. 50. Four stout wooden pins A, B, C, and D are driven into the ground at suitable places so that each thread which passes round all four pins represents the length of the warp such warp being long enough in circular form for the length of cloth required, taking into consideration that section which cannot be woven, but which, if desired, may be used to form a fringe at each end of the cloth.

A woman E fixes the end of the thread from the ball F to the pin A, and then passes the thread successively partially round B, C, and D to A, as depicted by the direction the woman E is following. The thread is then passed round the pin A, but the direction is then reversed, i.e. the second thread goes round in the order A, D, C, and B to A. These two orders are repeated for every pair of threads in the warp. Another woman G sits on the ground near the pin D and forms a loop round one thread from each pair, alternate threads of the warp, to another pin H, and thus makes at this point what we have termed a "heald-rod" very similar to that illustrated in Figs. 26 and 49. The distance between the rods D and H will represent the depth or length of the loops on the "heald-rod."

CHAPTER IV

TRAY LOOMS

THE method of weaving just described and illustrated was probably in vogue before that which obtains in the so-called "tray looms." One type of the latter is illustrated in Figs. 51 to 53, which show respectively a side elevation, an end elevation, and a plan. The loom receives its name from the fact that the three sides, A, B, and C, together with the frame D and the bottom E, form a kind of tray or box, while a further receptacle F is formed by the cover or lid G. The whole is made of wood, and the receptacles just mentioned serve to keep the yarns and other necessities for weaving.

A small warp beam H is supported, as shown in Figs. 51 and 53, by two upright wooden brackets J, and the ends of the warp beam are prolonged so that one may be provided with a hand wheel K and the other end with a ratchet wheel L, and its pawl M. The pawl M is fixed to the bracket J (see Fig. 51) by means of a screw and below the ratchet wheel L; it would be in a more stable position, however, if it were placed above the wheel L, although the bracket J would have to be lengthened for such an arrangement.

In the plan view, Fig. 53, the warp beam H is shown in position, and the warp is built upon the beam H in such a way that the total width of the threads is reduced gradually as indicated by the stippled ends N. In this way there is no necessity to use what are known as warp beam flanges.

In the warp in Fig. 53 fifteen threads are illustrated, and for distinction are alternately marked in solid black and rope-like effects. These 15 threads, or any other suitable and possible number, are threaded, or, as it is technically termed, "drawn" through the frame D, Figs. 51 to 53, in the following manner.

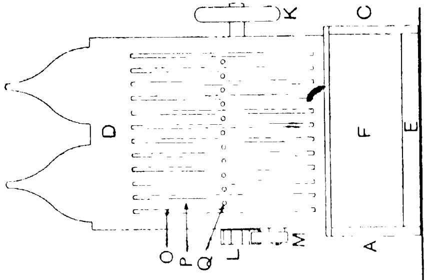


Fig. 52.

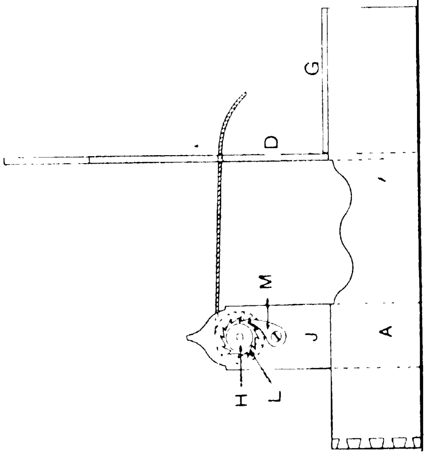


Fig. 51

Long slots O, twelve in Fig. 52, are cut in the frame D, and in the middle of each of the eleven parts P thus formed between the slots, a hole Q is drilled or else made with a red-hot wire or needle. The threads

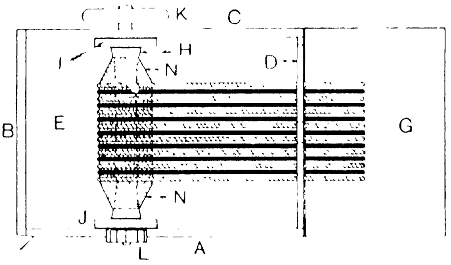


Fig. 53

of the warp are inserted in regular order through these slots and holes the odd-numbered threads 1, 3, 5, 7, etc., being in the slots O, and the even-numbered threads 2, 4, 6, 8, etc., in the holes Q, so that when all

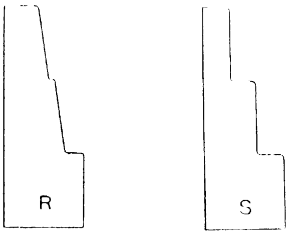


Fig. 54.

the threads have been drawn in, they will appear somewhat similar to that illustrated in Figs. 51 and 53. The articles R and S, Fig. 54, will be explained shortly.

Now the frame D is really the shedding apparatus, but in these particular tray looms it is usual to allow

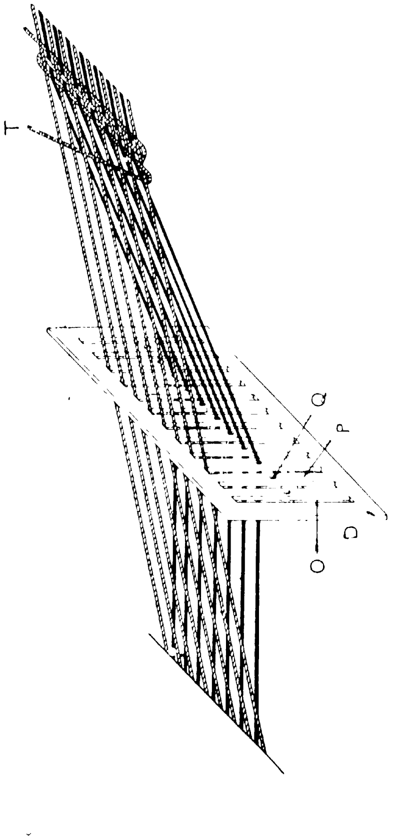


Fig. 55.

the frame D to remain stationary on the top of a table or stand, and to move the threads up and down to form the two kinds of sheds which have been already described.

In Figs. 55 and 56 the frame D has been drawn without the tray, and the two views illustrate the method of working in order to produce the pattern. In the first place, it should be stated that there are only two possible movements, and as under :

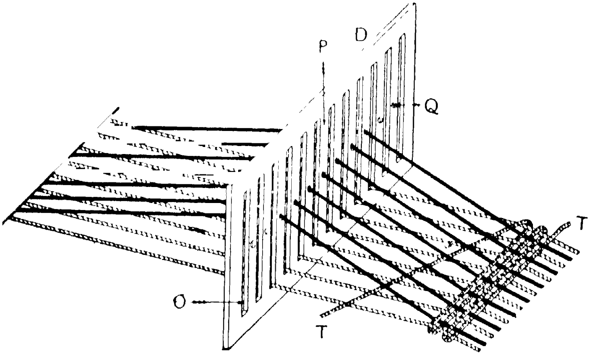


FIG. 56.

1. When the warp threads or the cloth on the right of the frame D are raised, as in Fig. 55 ; and

2. When the same warp threads or cloth are depressed, as on the right in Fig. 56.

When an attempt is made to raise the threads without moving the frame D, as it would be necessary to do in practice, it will be seen that the seven dark threads in Fig. 55 are kept near the middle of the bars P in virtue of these seven threads being through the holes Q. On the other hand, such a movement would cause the eight light threads to slide up the slots O until they reached the top of the slots, as is shown clearly in the illustration. This action obviously separates the warp threads into two distinct layers, and while they are thus separated, the weft T is passed between either from left to right as depicted in Fig. 55, or from right to left. This particular shed or opening is represented on point or design paper by the 15 horizontal squares marked T^1 near the middle of Fig. 57, while the corresponding line representing the movements of two leaves 1 and 2 in actual weaving to secure the same result in the fabric is shown by the lower horizontal line of two squares in the same figure, and also marked T^1.

The next operation is that of attempting to carry all the threads and the cloth into the low position as exemplified in Fig. 56. As before, the seven dark threads are kept in the middle of the bars P by the holes Q, but the eight light threads slide downwards, pass the dark ones at the centre, and ultimately reach the bottom of the slots O as represented in the drawing. This movement forms the opposite shed as represented by the line T^2, near the middle of Fig. 57, and the weft T is again passed through, this time in the opposite direction, that is, from right to left. The corresponding movements of the two leaves 1 and 2 are shown by the two squares T^2 in the small plan at the bottom; this plan will be recognised as the plain weave.

The two distinct movements of the frame D, Figs. 55 and 56, are repeated in order that the cloth may be made with successive pairs of picks or shots. Each pick of weft may be placed in position, that is, close to the last one inserted and known technically as the "fell" of the cloth, by a comb as already explained, or by a lath inserted into every shed as illustrated in Fig. 49, and, of course, withdrawn before the next shed is formed.

Two colours of warp and one of weft are used, as exemplified in Figs. 55 and 56, for the sole purpose of distinguishing between the groups. Self colours, that is, warp and weft of the same colour, would, in general, be used. Some very pretty effects, however, can be obtained when different colours are used. The effect in the woven fabric with three distinct colours would, under condition III (p. 15) in regard to the setting of fabrics, be somewhat similar to that depicted at U in the upper part of Fig. 57. This is termed a "colour effect," and, in that illustrated, 15 threads of warp and 6 picks of weft are shown. Picks 1, 3, and 5 are the same as line T^2, while picks 2, 4, and 6 are the same as line T^1. Instead of the warp being seven dark threads and eight light threads as in Figs. 55 and 56, there are eight dark threads and seven light threads in the colour effect. It is only a different method of starting, however, for the actual colour effect in both cases would be identical. The effects in U formed by the dark and light threads are shown respectively in solid black and criss-cross markings, while the effect produced by the weft is illustrated by the stippled (nearly white) squares. It will thus be seen that, with choice selections of harmoniously coloured yarns, very attractive effects can be secured by the simplest type of weaving and with one colour only of weft.

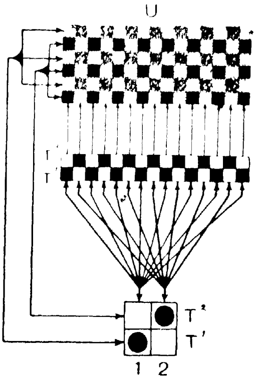


FIG. 57.

Figs. 58 and 59 are two photographical reproductions of a somewhat similar loom to that illustrated in the line drawings in Figs. 51 to 53, while the two movements of the warp threads and cloth to the highest and lowest positions, as explained in connection with Figs. 55 and 56, are also demonstrated.

The narrow cloth in Figs. 58 and 59, first without fringe and then with a fringe, is one of a number woven several years ago by the author for the late Sir Arthur Mitchell, K.C.B. The effect in this cloth is quite different from that illustrated diagrammatically at U in Fig. 57, and the structure of the fabric is also

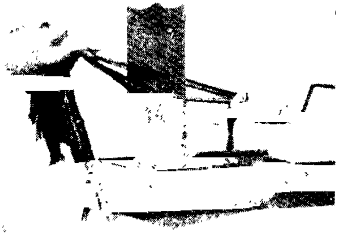


Fig. 58.

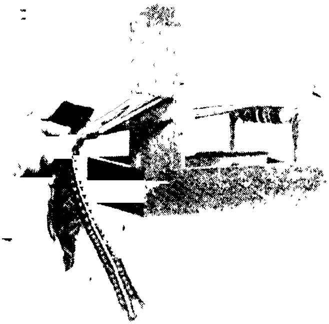


Fig. 59.

different, being a typical example of a cloth with a maximum number of warp threads and a minimum number of weft picks as per condition I (p. 15). There are two colours of warp, and the threads of the warp are shown clearly on the warp beam.

One of the articles R and S, Fig. 54, is also shown here, particularly in Fig. 59. Its use is for the formation of a fringe. The weft, on emerging from the left-hand side of the fabric, is passed over the board and then under before it goes through the shed from left to right. In this way a selvage is formed on the right-hand side of the fabric and a fringe on the left. Different lengths of fringes may be made according to which part of the wooden board in Fig. 54 is used, or the length may be made to vary from point to point, with care, and thus produce a kind of scalloped fringe. The fringe may be left in loops or cut as desired. It was stated that in some of the northern districts of Scotland such methods of weaving were practised to make the narrow fabrics which join the drones of the Highland bagpipes.

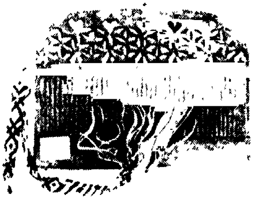


Fig. 60.

A much more elaborate piece of work, made in a similar frame, but without the box, is that reproduced in Fig. 60. This was also woven by the author for the late Sir James Key Caird, Bart. The frame came from some part of Africa, and in it was a dilapidated fabric of the same design as that near the end. The two distinct designs shown in this narrow fabric were executed for the above gentleman to assure him that such work was possible in a simple frame of this kind. The upper part of the frame is elaborately carved, as illustrated.

In this particular case, however, it was absolutely necessary to adopt a system of hand selection in order to produce the ornamentation on the fabric, although the ground or foundation of the fabric, which is, however, different from that in Figs. 55 to 59, was woven by the method already described in connection with the latter figures.

The method adopted by the author is demonstrated in Figs. 61 and 62. The latter view shows part only of the frame D, although the actual distance between the holes Q and the bottom of the slots O is greater than that illustrated; the distance illustrated, however, will serve the purpose of demonstration quite well. The arrangement of the 33 threads which formed the warp in Fig. 60 is shown in Fig. 62. This arrangement was necessary in order to weave the particular ground structure of the fabric; and four repeats of this ground weave are represented in the design V, Fig. 62, on the right, the unit plan weave being in solid squares on four threads and two picks. It will be seen from the arrows which join the first four threads of the design V to four threads in the frame D that the ground threads are represented in pairs two stippled and two with vertical marks. On the other hand, the threads which form the ornament, or the actual design on the cloth, are displayed by solid black circles in the frame D in Fig. 62, and by solid black lines in Fig. 61.

An examination of the threads in Figs. 60 and 61 will show that a figuring thread (solid black) appears between each pair of ground threads, and that all the figure threads are drawn through the long slots O of the frame D.

Fig. 61.

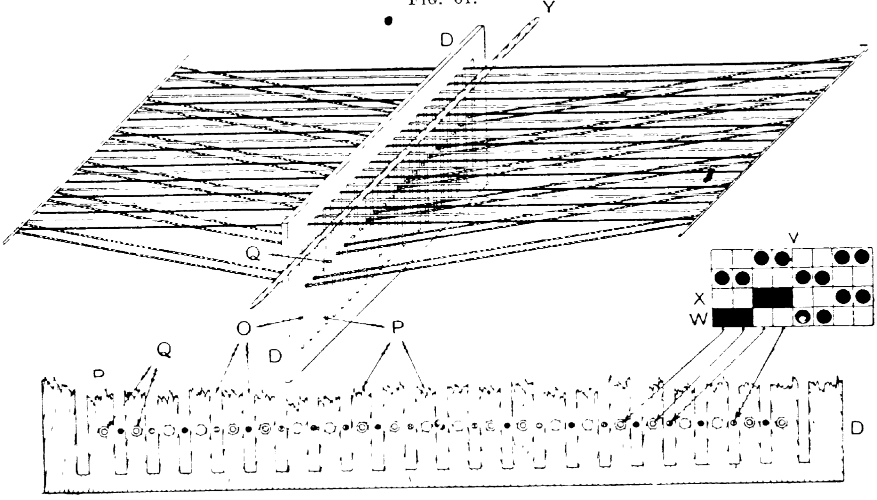


Fig. 62.

The draft for the ground threads is as under:

2 threads through two successive holes Q in the parts P of the frame D.

2 threads through the first and third of the next long slots O of the frame D, and so on for each group of four ground threads.

The foundation or ground structure, shown by the design V in Fig. 62, is produced by the same two movements of the frame D as explained in connection with Figs. 55 and 56. Thus, assuming in this case that the end of the warp on the left in Fig. 61 and the cloth on the right are fixed to rods as indicated, the frame D itself may be raised and lowered. When it is raised, it will carry all those threads which are in the holes Q above the threads which are in the slots O; whereas when the frame D is depressed, as illustrated in Fig. 61, it will carry all the threads in the holes Q below those which occupy the slots O.

These two movements will clearly separate the ground threads into the order indicated on picks W and X in Fig. 62, and in every succeeding pair of similar movements. And this represents all that can be done mechanically, so to speak, by the movements of the frame D for the cloth illustrated in Fig. 60. It is not difficult to understand, however, that while these two movements of the frame D are taking place for the ground threads, the figuring threads shown in solid black would accompany those ground threads which are in the slots, and thus interweave in precisely the same order, unless some provision is made to restrain their movements. Some provision is absolutely necessary; indeed, the threads for the ornament have to be picked or selected in some way, say by two sticks, one only of which is shown at Y in Fig. 61.

The demonstration of the hand selection to work in conjunction with the two movements of the frame D will be more clearly understood if we present the actual design for the cloth, and indicate how the weaving would be conducted in modern power-looms.

The complete design for the cloth illustrated in Fig. 60 is shown at A, Fig. 63, and contains 33 threads and 18 picks. The actual design for the ornamentation appears at B in the same figure. In the design B there are 11 threads, just the same number as there are figuring threads in Figs. 61 and 62.

The design A, and the weaving plan C, are representations of modern practice for power-looms, but the former is actually essential to show the real structure of the cloth for any method of production. Plan D shows 8 threads and 18 picks of the ordinary plain weave, while plan E, which embodies several repeats of the design V, Fig. 62, shows 8 threads and 18 picks of the actual ground of the fabric under consideration. The similar arrangement of crosses in design A, Fig. 63, represents the 22 ground threads, and, as already demonstrated, these threads are capable of being woven by two distinct movements of the frame D, Fig. 61.

In modern work, however, these two distinct movements would require two frames or leaves healds, gears, or cambs, as they are termed in different districts and hence the threads in crosses in design A, Fig. 63, are marked 1 and 2, while the corresponding marks in the weaving plan C indicate the movements for 18 picks of these two frames or leaves. All those threads marked 1 in the design A are alike in movement, and all those marked 2 are also alike, but different from those marked 1.

The 11 threads of the design B, Fig. 63, are reproduced in solid black in the design A, and their positions with regard to the ground threads are identical with the corresponding threads in Figs. 61 and 62. On the same principle of arranging all like threads under the same number of frame or leaf, we shall see that

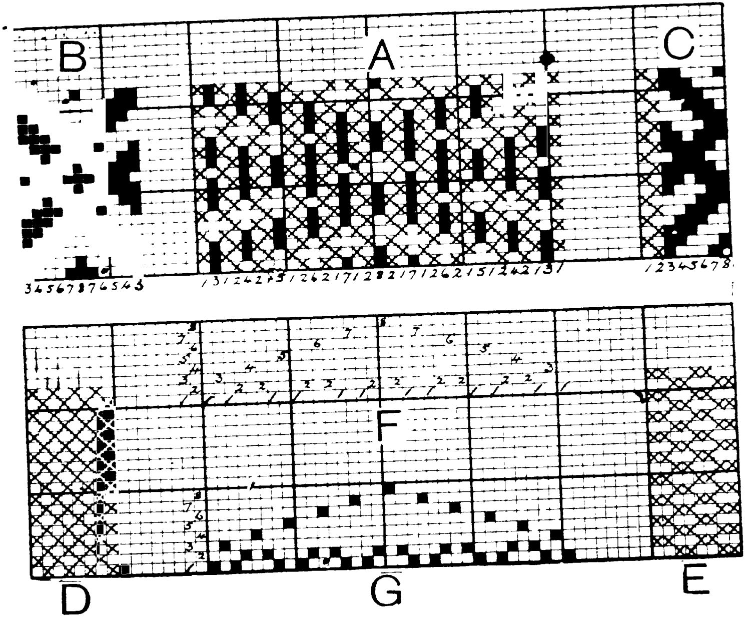

B
A
C
3456787654 3
1312421512621712821712621512421 31
12345678
F
D
G
E

FIG. 63.

six other frames or leaves would be required Nos. 3 to 8 inclusive in designs A and B in modern power-looms. The orders of movement of these extra six leaves (3 to 8) for 18 picks are indicated alongside Nos. 1 and 2 in the weaving plan C. Hence eight leaves in all (1 to 8) would be necessary, and operated as in the complete weaving plan C. This statement assumes that the 33 threads of the warp and of the design A were drawn through the "mails" or "eyes" of the eight leaves in the order indicated by the numbers under the design A. These numbers constitute, as already stated, what is known as the "draft" of the healds, and two other methods of indicating the same order are displayed at F and G in the same figure; in these two cases the eight horizontal rows of small squares represent the eight leaves of the healds, as demonstrated by the numerals 1 to 8 on the left of each draft.

The two simple movements of the frame D in Fig. 61 and the hand selections have to perform the same function for the cloth in Fig. 60 as that performed in modern hand- or power-looms by eight different frames. There is, however, a considerable difference in the speeds of the two methods of weaving.

Consider, for example, the disposition of all the 33 threads of the warp in the frame D in Fig. 61 for the first pick or first horizontal row of small squares in the design A, Fig. 63. The downward movement of the frame D, as demonstrated in Fig. 61, has carried 12 ground threads, all marked 1 in the design A, Fig. 63, to the lowest position, and at the same time has allowed 10 ground threads, all marked 2 in the design A, Fig. 63, to rise to the top of the slots. It is quite evident, however, that if all the black figuring threads in Fig. 61 were under no restraint, they would all appear at the top of the slots along with the 10 white ground threads in the adjoining slots, and exactly as indicated if we neglect the presence of the stick Y, or if the stick Y alone were used.

Instead of this disposition of threads, it is clear from an examination of the first horizontal line of the design A, Fig. 63, that the three middle black threads, along with one black thread at each end, or five black threads in all, should be on the upper line at the top of the slots, while the remainder of the black threads should be on the lower level in company with those ground threads in the holes Q. It will thus be seen that there are two hand selections to make for each movement of the frame D, and hence the work proceeds very slowly indeed.

Considering the black threads only in Fig. 61, it will be seen that the stick Y is under 2, over 3, under 1, over 3, and under 2, which may be shown graphically as under:

$$\begin{array}{ccccc} 2 & & 1 & & 2 \\ & 3 & & 3 & \end{array}\ \text{rod } Y.$$

Now this order corresponds with the second horizontal row of the design B, Fig. 63, because these threads 1, 2, 6, 10, and 11 require to be on the surface of the cloth. But on the same line in design B, threads 3, 4, 5, 7, 8, and 9, those under the line or rod Y in the above graphical order require to be on the under side of the fabric; hence another stick, similar to Y, Fig. 61, should be threaded to hold these threads down below the lower set of ground threads. If the selecting for the two sticks is done with all the threads at the centre, i.e. on the same level, this disposition of the figuring threads can be secured. Thus, with the frame D raised until all the threads are level, the figure threads 1, 2, 6, 10, and 11 are picked out from above by the stick Y, while figure threads 3, 4, 5, 7, 8, and 9 are picked out from below by a second stick; then when the frame D is pressed down to its present position in Fig. 61, the two groups of figure threads will be held slightly above and slightly below the respective groups of ground threads. The opening thus formed by all the 33 threads for the weft will correspond to the second line of the complete design A, Fig. 63.

The amount of changing from pick to pick will clearly depend upon the configuration of the ornament.

The second pattern in Fig. 60 is a diagonal, and is much simpler than the diamond or lattice pattern, although there is just as much labour required for the insertion of the sticks. The design for the diagonal pattern is illustrated in Fig. 64, the solid part representing the unit design.

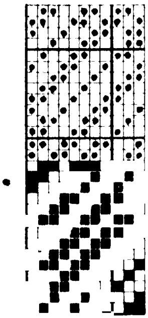


FIG. 64.

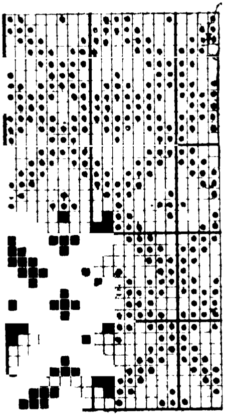


FIG. 65.

Neither design B, Fig. 63, nor the design in Fig. 64, is adapted for repetition in the way of the warp. This is quite apparent in the latter, and four repeats of the former are displayed in Fig. 65, the unit design in solid black, to show that, in a repeating pattern from this unit, the effect would be more or less rib-like, or "barry," as it is often termed. Nevertheless, the effect of a single unit, warp way, of this design is much more effective than a single unit made, say, from the design in Fig. 66. On the other hand, the unit in Fig. 66 is obviously adapted for repetition both ways, as is demonstrated by the four repeats.

A modification of the design in Fig. 66 appears in Fig. 67. In the latter design the three-float diagonal lines in both directions are continuous or unbroken, whereas in the former design they are not continuous, but alternate, as it were. A continuous effect can always be obtained with a float of an odd number, provided that the float is split on the first thread so that one more mark appears at the bottom of the design than what appears at the top.

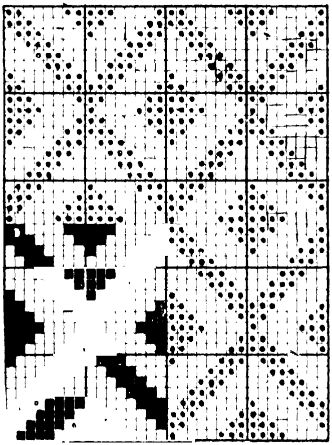


Fig. 66.

If $2n + 1 =$ the length of the float; then $n + 1$ marks should appear at the bottom, and n marks should appear at the top.

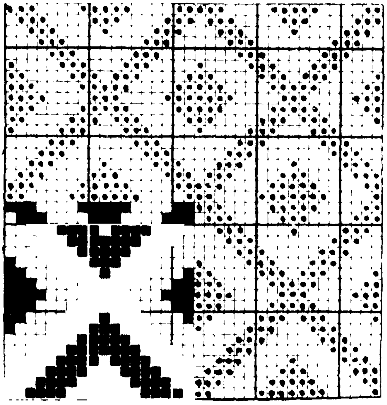


Fig. 67

In Fig. 67, $n = 1$, and

$2n + 1 = 3$, the length of the float.

Therefore, $n + 1$, or 2 marks, appear at the bottom, and n, or 1 mark, appears at the top.

CHAPTER V

THE PREPARATION OF WARPS OR CHAINS FOR THE LOOM

COMPARATIVELY short warps or chains for the frames or looms can be made by the method illustrated in Fig. 50 and by other similar simple methods for use in the tray looms illustrated in Figs. 51 to 62. A different way has to be practised, however, for the longer warps which were used extensively in this country a few decades ago in hand-loom weaving, and which are still largely used for the same purpose in several foreign countries.

Except in very rare cases, however, the hand-loom is no longer, under similar conditions of labour, a serious competitor with the power-loom, and the many claims which are adduced regarding hand-made products are much more imaginary than real. It is quite true that there are still thousands of hand-looms in existence in districts where no attempt has been made to introduce power-looms, but few of these hand-looms are competing with the modern power-looms in the manufacture of cloth for the open markets of the world.

It has been recently stated that 270,000,000 lb. of yarn were used in India during the year 1914 in the hand-loom weaving industry. This at first sight appears, and really is, a stupendous quantity, and is calculated to speed up the energies of those who are trying to boom the hand-loom branch of weaving; but when it is known that in the jute industry alone in the same country, and mostly in the vicinity of

Calcutta, more than 2,000,000,000 lb. are used annually, the comparative insignificance of the hand-loom requirements, when compared with those for power-looms, is clearly emphasised. The above hand-loom product represents approximately 1 lb. per head of the Indian population.

The hand-loom is still a most useful adjunct to many industries, but its use lies not so much in the direction which is often claimed for it as in its adaptability for making changes in experimental work. For pattern weaving in the first stages the hand-loom will probably always be used, and more will be said about this subject when the practicable hand-looms are discussed and illustrated.

In the meantime it may be stated that the methods of preparing warps to be described are used, not only for pattern work, but also for piece work, as well as for certain classes of warps which are ultimately woven in various kinds of modern power-looms.

The simple method practised in certain Eastern countries, and illustrated in Fig. 50, could be performed with more ease if the pegs or rods were arranged so as to enable the operative to wind on the yarn with a minimum amount of stooping. In other words, it is only necessary to drive sticks or rods into a wall or other upright stable erection at points, say, from two to six feet from the ground or floor, and then the operation which has already been described with the use of vertical pegs can be conducted similarly with horizontal pegs. As a matter of fact, a method very similar to this is still practised in certain industries where fancy warps have to be prepared. Instead, however, of the primitive method of driving pegs into a wall, substantial wooden or iron posts are provided with holes into which stout wooden pegs are inserted. Such fixtures, technically termed "warping woofs" or "bar-trees," were, within the memory of the writer, used in some of the Yorkshire woollen mills, and are probably still used for similar purposes in many mills in other manufacturing centres. In the particular county mentioned these stout wooden or iron upright posts were arranged so that the horizontal distance between the pegs in the posts was equal to 10 ft. in some cases, and to 3 yd. 3 in. in other cases. These two distances or measurements were used in different towns and represented what was known as "a string." Of course, the distance apart is solely an arbitrary one. This measurement may simply have been one of convenience adopted in the hand-loom weaving days, and the word "string" may have arisen from the method of testing the horizontal distance between the pegs in the upper and lower parts of the posts. We are not specially concerned about the etymology of the word "string." At all events, it was a common practice to make warps, the length of which was given in "strings," and not in yards.

In addition to the warping woof or "bar-trees," some kind of receptacle is essential to support the bobbins, cops, or the like, and so arranged that the yarn may be drawn with ease from each cop or bobbin, and that both hands of the warper may be free to manipulate the various operations which arise during the warping of a chain.

Such an apparatus for modern factories is termed a "bank" or a "creel," and for hand work the same names are retained. Before describing the apparatus, and the method of making warps or chains by its aid, we introduce, in Fig. 68, a photographical reproduction of a complete equipment. The "warping creel" is situated on the left in the foreground; the "warping woof"—much smaller than those mentioned above—is on the right. The threads of yarn, black and grey, in the present instance come from cops in the creel, upwards and through suitable guide-eyes, termed "curls," on account of their shape, from which point the warper, who stands between the two frames, facing the observer, and at a point approximately opposite the white rectangle, conveys them to the pegs or pins of the warping woof so as to form a warp or chain.

In Fig. 68 the threads appear in a festoon between the frames, and several threads have already been transferred to the pegs. It will be seen that those threads on the pegs constitute six journeys from side to side of the warping woof; therefore, if the horizontal distance between the pegs were 10 ft. or one string, the actual length thus shown would represent, neglecting the oblique direction of each stretch, 60 ft. or six strings. In practice, the pegs in the posts are much closer vertically than are those illustrated in the figure.

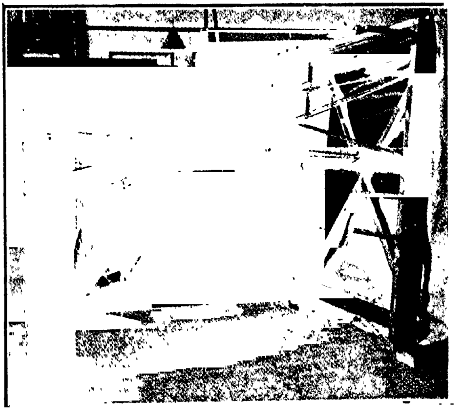


FIG. 68.

An end elevation of a warping woof is illustrated in Fig. 69, a sectional elevation of a warping creel appears in Fig. 70, while an end elevation of the creel and three enlarged and detached views of the "curls" or guide-eyes are shown in Fig. 71.

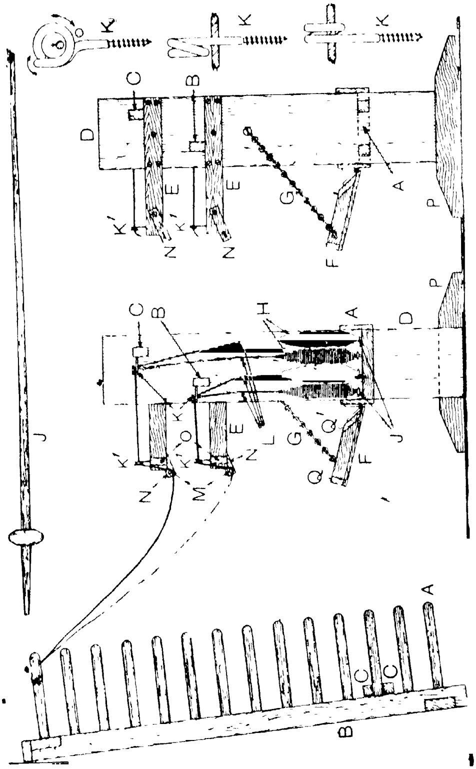


FIG. 71.

FIG. 70.

FIG. 69.

The pins or pegs A in Fig. 69 are about $1\frac{1}{2}$ in. in diameter and project from the side beams B about 12 in. These side beams are much thicker than that illustrated in Fig. 69; those in Fig. 68 are 6 in. deep and 3 in. broad. The pegs must fit well and be of hard, well-seasoned wood, say beech, because there is a considerable amount of tension on them when they hold a full warp. Especially is this the case when the warp threads approach near the ends of the pegs.

The warping creel (Figs. 70 and 71) consists of a long shallow cop-box A, and two long bars B and C, all of which are supported by the two end frames D. Fixed to the outside of each frame D are two arms E, while an adjustable box F is held at the desired angle by means of two chains G and two hinges. The cops of warp yarn H, of which four are shown in Fig. 70, come direct from the mule spindle or other source, and each is supported vertically on a "skewer," "broach," or "spit" J, an enlarged view of which appears above Figs. 70 and 71. This broach J, and the "curls" K, in the separate views to the right in Fig. 71, are drawn to a scale eight times the size of that employed for the remaining parts of the figures.

The hole in the centre of each cop corresponds in size to the mule spindle upon which the cop was wound during the process of spinning, and into this hole the skewer or broach is placed until the bottom of the cop reaches the thickened part or whorl. The short end of the broach is then placed in a hole in the bottom of the cop-box A, as shown in Fig. 70. The yarn from the required number of cops may be guided by the cross-wires L to the first two sets of horizontal curls or guide-eyes K in the bars B and C, or the two bars may occupy positions nearer the back of the frame D and thus dispense with the guide wires L. The threads are then entered into the upper and lower sets of vertical curls K^1, and finally under the tension wire M, which is secured to, and may be raised or lowered by, the short arms N. The threads are entered into the curls as shown by the arrows in the upper detached view on the right of Fig. 71. The two sets of vertical curls are inserted into the two horizontal bars O. These bars are fixed to the two arms E, and the latter are secured to the side frames D, as shown in Fig. 71. The complete creel is supported by wooden feet P.

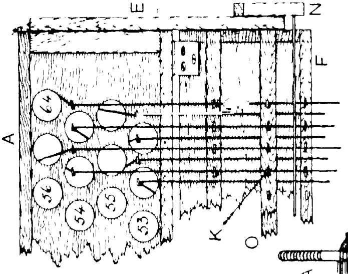


Fig. 74.

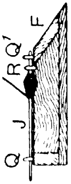


Fig. 75.

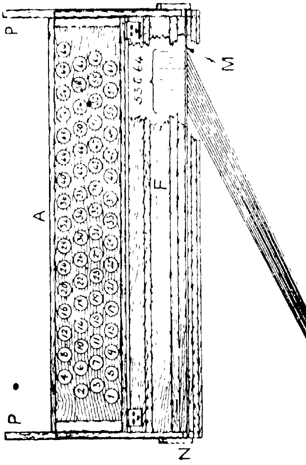


Fig. 72.

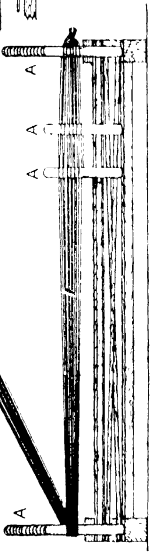


Fig. 73.

Further details of the warping creel and woof are shown in Figs. 72 to 75. Fig. 72 shows a complete plan of the cop-box A, which in this case has provision for 64 cops. The hinged box F has a section cut away, and in this gap we have introduced twelve threads, those from cops numbered 53 to 64 in the cop-box. These twelve threads are shown under the tension wire M, and also arranged on the four pegs A in the upper row of the warping woof or bar-trees as they would appear in practice for the first stretch or length of the warp on the pegs. This view will be referred to later in the description of the warping operation.

Fig. 74 is an enlarged view of the right-hand side of the warping creel with the positions of cops 53 to 64, and the order in which the threads are passed through the various curls K and under the tension wires M. In this view only 8 threads, 57 to 64, are shown coming from the cops. Fig. 75 illustrates the use of the hinged box F. In many cases, when the yarn has been withdrawn from the cop until the latter is approximately the size indicated, the remaining bit is difficult to pull off with the cop and broach vertical. It is the usual practice to take them both from the cop-box A, as shown in Fig. 70, and arrange them as in Fig. 75 by passing the end of the long part of the broach through the left-hand staple Q until the shorter end behind the whorl R can be entered through the right-hand staple Q^1. When the box is tilted as shown in Fig. 70, the whorl limits the downward movement of the broach and cop, and enables the two to rotate with comparative ease until all the yarn is withdrawn from the cop, when a fresh cop is placed on the broach and the latter re-entered vertically into its hole in the cop-box. In Fig. 68 there are a few of the broaches in the hinged box, the one nearest the observer having a cheese or roll on it.

A front view of the warping woof is shown in Fig. 76. One end of the adjustable bar C is arranged to fit on any of the pegs A, while the other end is made with a slot so that the bar will be long enough for any oblique position into which it is desired to place it. This bar C can evidently be placed at any point between the top and bottom rows of pegs, and thus provision is made for the warping of all lengths within the

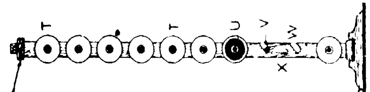


FIG. 78.

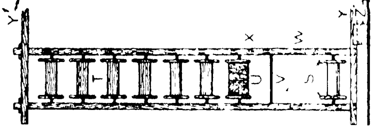


FIG. 77.

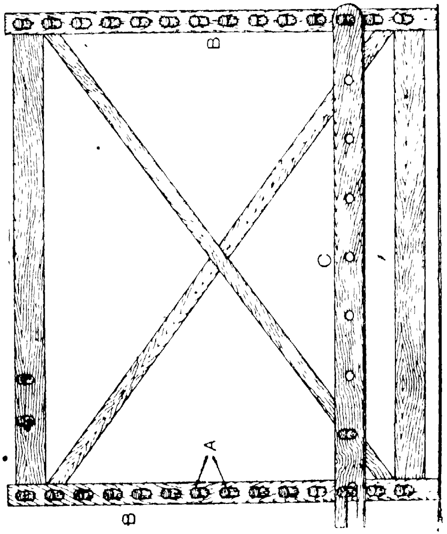


FIG. 76.

maximum length. The maximum length in all cases is found by multiplying the number of pegs in the two end bars B by the horizontal width between the pegs. The holes in the bar C are 9 in. apart, so that this particular warping frame or woof is 8 × 9 = 72 in., or two yards in width; hence the total length of warp could not exceed 28 × 2 = 56 yd., but any length up to and including this can be made.

Fig. 77 shows a front elevation of one row of bobbins in a warping creel or "bank" suitable for bobbins or the like, while Fig. 78 is an end view of the same. Cheeses, rolls, or spools are made without the flanges S, as the particular method of guiding the yarn during the winding process automatically forms the ends of the cheese. In Figs. 77 and 78 there are seven empty bobbins T, one full bobbin U, one pin V upon which the bobbin rotates, and the upper ends of one of the oblique slots W for the entrance and withdrawal of the pin V. There is, therefore, provision for 10 bobbins in a vertical row, and any desired number or practicable number of rows can be combined by fixing the desired number of vertical bars X, as shown, and in the sectional elevation in Fig. 77. Each vertical bar X is fixed into a recess in the bottom bar Y, and the upper ends passed through corresponding openings in the upper bar Y^1. A hole is drilled through the part which projects above the bar Y^1 and a pin passed through each hole to keep the bars fixed. The whole is then supported on two feet Z.

For simple handicraft work the warping woof and creel illustrated in Figs. 68 to 76 would, in general, be too costly and too large, since the two, with the necessary space between them, occupy much space, say, approximately, 8 square yards. Short warps for narrow textures could be made on the same principle, but with much simpler apparatus. The method of driving pegs into a wall, or inserting them into holes in upright bars fixed to the wall, would answer quite well for a warping woof. A portable flat board, with holes for the broaches and two horizontal bars provided with notches or wide saw-cuts for the threads, would serve for the creel.

The method of making the warp would be the same whether the simple appliances suggested, or the more elaborate ones which have just been illustrated, were employed. Thus, the cops would be arranged in the cop-box A of the creel, Figs. 70 and 72, or on the portable board, in the order required, if there should happen to be two or more different coloured threads required for the pattern on the cloth. In Fig. 70 the order appears to be as follows: One thread of light yarn, one thread of dark yarn, one thread of light yarn, and one thread of dark yarn; but since the threads from the two left-hand cops go to the guide-eyes or curls K in the bottom rail B, Fig. 70, and the threads from the two right-hand cops go to the guide-eyes in the top rail C, and since the threads from these two sets of guide-eyes must be taken alternately to form what is known as a "lease," it follows that the actual order of coloured threads in the warp and in the cloth will be: two threads of light yarn and two threads of dark yarn.

The grouping of the cops in the cop-box in Figs. 72 and 74 will show that all odd-numbered threads are controlled by the bottom rail B, Fig. 70, and all even-numbered threads are controlled by the top rail C. Although the warper, as the operative is named, stands, as already mentioned with reference to Fig. 68, with the creel on her right hand and the woof on her left hand – that is, to the right of the cop numbered 64 in Figs. 72 and 74—it so happens that this cop, in general, is the last in the pattern or colour arrangement; therefore, when the cops are being entered into the cop-box A, it is necessary to start on the left when reading the correct order of the coloured threads in the warp, or to read the order of warping backwards if it is preferred to start on the right. Such being the case, it is evident that the warping arrangement of the four cops in Fig. 70 is two light and two dark, as stated.

Any convenient or practicable number of threads, large or small, can be used if all the threads are of the same colour; but if the warp is to be composed of different colours arranged in some comparatively short cycle, a fixed number of cops, according to the type of pattern, would be necessary. After all the threads have been entered through the guide-eyes in the manner described in Fig. 71, they are brought under the two tension wires M, all the threads of the two sets grouped together, and a knot tied at their ends. When all the threads are drawn to the same tension, they will appear as indicated in Fig. 79. In this case there are four threads in each layer, consequently the warp is being made with eight cops in the cop-box. The guide-eyes, tension wires, and supporting rails are shown quite distinctly.

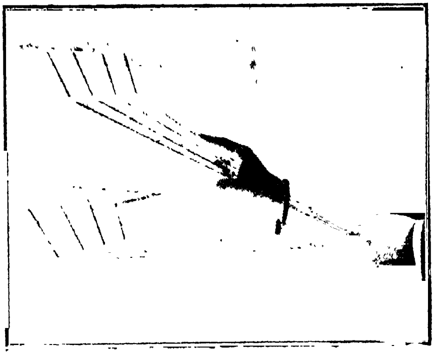


FIG. 79.

The two layers of threads are so made to facilitate the operation of "picking the lease," and Fig. 79 shows the first step in this operation. The first finger of the left hand, or the thumb, whichever happens to be preferred, is inserted between the two layers and in front of the knot to draw all the threads comparatively tight. Then the right hand is moved towards the thread nearest the operator in the upper layer, so that the first finger passes over the thread and the thumb underneath it. The right hand with the enclosed thread is now moved downwards into a corresponding line with the lower set of threads. The hand and thread are now moved towards the nearest thread in the lower set, but in this case the first finger passes underneath the thread, while the thumb passes over it. The same, or rather similar, two movements are made for each pair of threads, one in the top layer and one in the bottom layer, so that all the threads in the upper layer pass under the finger and over the thumb, and, alternating with these, all the threads in the lower layer pass over the finger and under the thumb. Each complete movement adds one more thread to those already arranged on the finger and thumb, and this order may be preserved quite securely, when necessary for any purpose, by joining the tips of the finger and thumb and thus closing the entrance or exit. The appearance of all the threads collected in this manner would be somewhat as shown in Fig. 80, where the last thread of the eight, that on the left in the bottom layer, has just been added to the remaining seven in the manner explained.

Fig. 80 shows that the first finger of the left hand and the thumb of the right hand are at opposite extremities of the same slot or opening, while the first finger of the right hand is in a different opening. The positions of the thumb and two fingers correspond with the first three pegs on the left hand in the upper row in Figs. 68 and 76, and the threads are transferred from the fingers and thumb in this order to the above-mentioned three pegs. Then the warper grasps all the threads in her hand, walks towards the other end of the warping woof, and passes the threads in a group over the upper peg, as shown in Fig. 73. This view, as well as Fig. 68, shows the connection between the warping creel and the warping woof.

The warper now walks backwards and forwards between the two vertical rows of pins in the warping woof, and simultaneously draws the yarn from the cops. Each time the right and left side of the stretch is reached, the group of threads is passed over a peg until a sufficient number of journeys has been made for the required length of the warp. Eight threads are shown in Figs. 68, 79, and 80, but 12 threads are shown in Figs. 72 and 73.

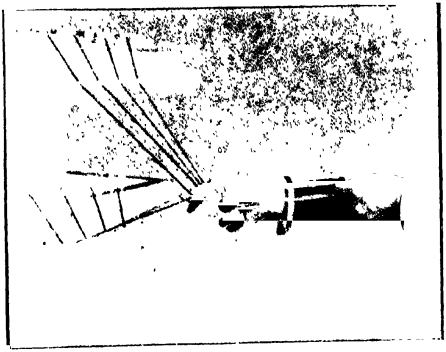
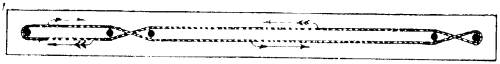


FIG. 80.

If the length of warp required were one "string"—that is, the distance from one side of the warping woof to the other—two pins would be required on the right-hand side, instead of one, as illustrated in Fig. 81. In this particular case the warping is supposed to have been done with one bobbin or cop only, and the arrows show the direction followed by the single thread over and under the five pegs, while the plan view in Fig. 82 represents four complete lengths on the pegs, and the fifth length started on the left-hand pegs. It will thus be seen that there is a "lease" at both ends of the warp, one formed by the pegs B and C, and the other by the pegs D and E, but that an extra peg A is used for the starting point of the warp. Both these leases may be exactly the same, so far as the relative arrangement of each pair of threads is concerned; but it often happens and in most cases in practice that the lease formed by the pegs D and E differs from the lease formed by the pegs B and C. The lease formed on the pegs B and C is always the same kind, and is called the "weaver's lease," the "drawing-in lease," the "top lease," or the "thread-by-thread lease," and the length of warp between the pegs B and A is introduced solely to enable subsequent operations to be performed without sensibly disturbing the position of the lease. On the other hand, the lease formed by the pegs D and E is called the "pin lease," the "foot lease," or the "beamer's lease." This end of the warp goes first to the weaver's beam, and will be explained more fully later.

Fig. 81.



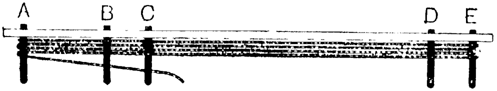


Fig. 82.

If we consider the simplest case, that illustrated in Figs. 81 and 82, it will be evident that the single thread must be carried forward, as indicated by the single-feather arrows, and then backward, as indicated by the double-feather arrows, until the number of journeys equals the number of threads required to make the particular cloth under consideration. When this number has been reached, the thread is broken off the cop or bobbin, and tied to the others at A if the number is even, or to those at the end E if the number is odd. But while the completed warp or chain still remains on the pegs of the warping woof, it is necessary to preserve the two leases so that they may be used for the purposes mentioned at the proper time and place.

A piece of string, but more often a group of threads from those which are for the moment in the guide-eyes of the creel, is taken and introduced into the same openings as the pegs B and C, and as shown in Fig. 83. The two ends F and G of the lease-band are then tied together, and therefore the lease is secure. After tying the ends F and G, it is usual to pass the knot thus formed through the opening at H, then to draw it and the threads J tight; then to wrap the doubled lease band neatly and quickly round the body of the threads J, and finally to insert the knotted end amongst them to preserve all intact and to minimise all danger of entanglement. A similar lease band is inserted at the pin lease on pegs D and E, Figs. 81 and 82. The warp is now ready to be removed from the pegs, and to be taken to the beamer.

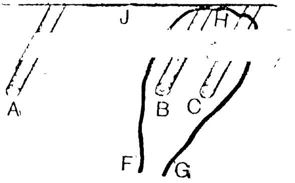


FIG. 83.

As already stated, if a long length is required, the threads in the group are taken forward and backward until the desired length has been reached. Suppose, for example, the distance between the two sets of vertical pegs in Fig. 84 is three yards, and that half a yard separated each pair of holes in the low adjustable bar, then it is evident that since the group of threads passes from side to side seven times and then through four divisions in the adjustable bar, there would be: 7 × 3 yd. + 4 × $\frac{1}{2}$ yd. = 23 yd. of warp.

If the number of threads in the creel or hank, that is, the number which the warper conveys from side to side, is the same as the number of threads in the warp for the loom, it follows that the warp would be finished when the pegs D and E were reached the first time. If, however, as is generally the case, a smaller number of cops or bobbins is utilised in the bank or creel, we should have:

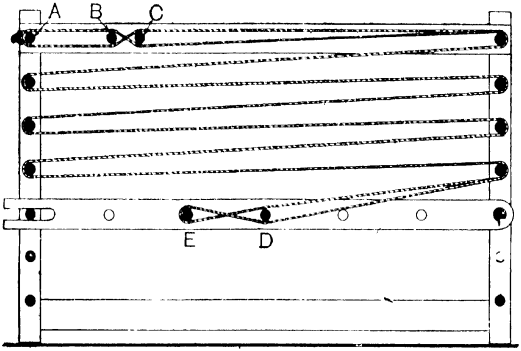


FIG. 84.

$$\frac{\text{Total number of threads in warp}}{\text{Number of cops in bank}}$$

= The number of separate journeys between A and E.

For example, let us suppose that a warp is required with 80 threads for the full width of a narrow cloth, and that two colours of warp yarn are to be used and arranged in the following order :

2 threads dark yarn.
1 thread light ,,
1 ,, dark ,,
1 ,, light ,,
1 ,, dark ,,
2 threads light ,,

8 threads in each unit, usually called a "repeat."

Then :

$$\frac{\text{80 threads in warp}}{\text{8 threads in repeat}} = \text{10 repeats of pattern.}$$

The above arrangement of coloured threads could be displayed as follows :

Dark	2		1		1		= 4
Light		1		1		2	= 4

8 threads × 10 repeats = 80.

If eight cops only were placed in the cop-box A, Fig. 72, they would be arranged in the four rows in the following way :

Row 4				D				L
Row 3		D				D		
Row 2			L				L	
Row 1	D				L			

where :

D = dark threads, and
L = light ,,

The thread-by-thread lease of the eight threads would be taken, as indicated in Figs. 79 and 80, the threads placed on the three pegs A, B, and C of the warping woof, and the group arranged on the pegs until D and E were reached. Then, if the pin lease or beamer's lease were wanted in groups of four, instead of singly, as shown in the foregoing figures, threads 1 to 4 would pass under peg D and over peg E, while threads 5 to 8 would pass over peg D and under peg E, and the first group of eight threads would therefore assume the position indicated at K, Fig. 85. The eight threads would then be reversed on the peg E and again placed in groups of four on the pegs E and D as shown at L. This second group of eight threads would then be placed alongside the first group until ultimately the pegs C, B, and A, Fig. 84, were reached. A thread-by-thread lease would then be picked as in Figs. 79 and 80, the threads thus arranged placed on the pegs C and B, Fig. 84, and then all the eight carried over the peg A. By this time 16 threads out of the necessary 80 threads would be on the warping woof, and these operations, once down the woof and once up the woof, would be performed five times, or 10 single journeys in all.

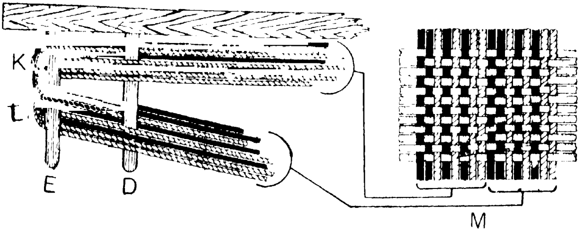


Fig. 85.

A double journey as described is often called a "bout" or a "round," while a single journey in either direction is, in consequence, called a "half-round" or a "half-bout." On the completion of the 10 half-bouts or five bouts, the eight threads would be cut. Four of them would be passed over the peg A, and the remaining four under the peg A, behind which all are tied together to finish the warp. Lease bands are inserted as described, and the top lease or weaver's lease end withdrawn from the pegs A, B, and C. The warper then puts her hand through the last loop which was formed between the pegs A and B, grasps all the threads about one foot further on, pulls them through the loop, and thus forms another loop through which the hand is again passed to draw a third loop through the second one. This process is repeated until the long length of 23 yards (in this case) is made or linked into a much thicker and shorter form, termed a chain; hence the word "chain" is often used to indicate a warp.

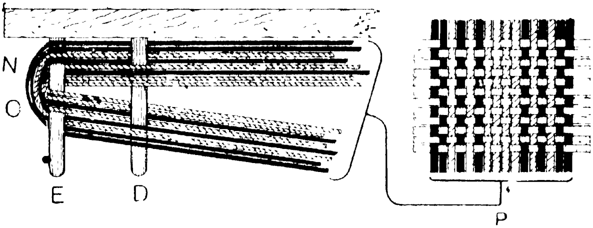


FIG. 86.

The method of turning the eight threads from K to L, as shown in Fig. 85, causes the same colour arrangement to obtain, and this order is preserved for each group of eight; hence, when the threads lie side by side in the loom, and interwoven with weft of another light shade by simple plain weaving, the colour effect on the surface of the fabric would be as seen at M, where 16 threads and 12 picks are shown. Each group of eight threads would add another unit or repeat in succession to the two repeats shown at M, so that finally the complete warp of 80 threads or 10 repeats would be interwoven with the light weft.

Now, if the same eight threads were warped, as shown in Fig. 86 that is, after the first group of eight had been treated as in Fig. 85, and as shown at N, Fig. 86 - the next group were placed on the pegs in the reverse order, it will be seen that the colour arrangement would consist of two groups of eight, so that 16 threads would constitute the repeat as demonstrated below :

$$\begin{matrix}\text{Dark}\\\text{Light}\end{matrix}\;\underbrace{\begin{matrix}2&&1&&1&\\&1&&1&&2\end{matrix}}_{\text{1st Group.}}\;\begin{matrix}\\+\end{matrix}\;\underbrace{\begin{matrix}&1&&1&&2\\2&&1&&1&\end{matrix}}_{\text{2nd Group.}}\;\underbrace{\begin{matrix}=8\\=8\end{matrix}}_{\text{16 threads.}}$$

Consequently, for a warp of the same number of threads we should have :

$$\frac{80 \text{ threads}}{16 \text{ threads per repeat}} = 5 \text{ repeats in the width.}$$

It would, therefore, require two half-bouts to make one repeat if the same eight cops only were used in the creel or bank. Each repeat of 16 threads would, when interlaced with light-coloured weft and with the plain weave, appear as represented by the colour effect at P.

The two methods of joining the first group to the second group, as shown in Figs. 85 and 86, are used to produce unsymmetrical and symmetrical patterns respectively, although the latter are often made in the same way as the former. For example, if it were found convenient to warp with 16 cops instead of eight, it is evident that the method of warping would in both cases be like that explained in connection with Fig. 85. Two repeats of the eight-thread pattern would be warped together, and one repeat of the 16-thread pattern. In both cases it will be seen that we should have :

80 threads 16 cops in bank or creel	5 half-bouts or journeys.

Longer lengths of warps can be made on what is called a "warping mill," and, although the lengths made on the largest warping mills are much shorter than those of the warps made by dressing machines and similar machinery, a considerable number of warps for power weaving are made on such warping mills. The circumference of these modern warping mills varies from 8 to 15 yards, but similar parts to such mills are included in the small warping mill illustrated in Fig. 87. It is a facsimile of one type of the larger mills, but is placed on a table instead of on the floor. (See *Jute and Linen Weaving*, Woodhouse and Milne, 1st edition, pp. 29 to 34; 2nd edition, pp. 43 to 50. Also *An Introduction to Jute Weaving*, Woodhouse and Ireland.)

FIG. 87

The bobbins in this case are assembled in a bank, slightly convex so that each bobbin is approximately tangential to the pull or direction followed by the thread to the mill, and similar in construction to that shown in Figs. 77 and 78. The threads from the vertical rows of bobbins are drawn in regular succession through the eyes of the "heck," which consists of two iron frames, each provided with a number of vertical bars. In the centre of each vertical bar is a hole for a thread. The two frames, which resemble closely two leaves or healds for weaving, can be raised alternately to form the thread-by-thread lease which was done by hand for the warping woof. When the lease has been formed, the group of threads is placed on a similar set of three pegs to those already described and as illustrated in Fig. 87. As soon as this is done, the mill is rotated by means of a handle and a rope. The latter connects the disc of the handle apparatus with the vertical posts or "spokes" of the mill.

The two leaves of the heck are supported by what is known as a "heck-box," and a rope or cord passes from the top of the heck-box to the central upright shaft of the warping mill. Consequently, as the mill rotates clockwise, when viewed from above in Fig. 87, the rope is unwound from the upright shaft and the weighted heck-box descends in some proportion as the mill rotates, and causes the group of threads to assume a spiral form on the circumference of the warping mill.

When the heck-box comes opposite the bottom lease pegs, the pin lease or beamer's lease is picked, and the threads placed on the two pegs. The mill is now rotated in the opposite direction by turning the handle the other way, and since the rope is now wound gradually on the upright shaft, the heck-box moves upwards in the same proportion until the thread-by-thread lease pegs are reached. The lease is again made by the heck, the threads placed on the three pegs, and preparations made for warping the third half-bout. The cycle of operations conducted for the first two half-bouts is repeated for every pair and for the necessary number of times. A complete description of a somewhat similar type of warping mill will be found in the work, *An Introduction to Jute Weaving.* Several calculations on the subject appear in the same book.

In Fig. 88 the warp is completed with four rounds

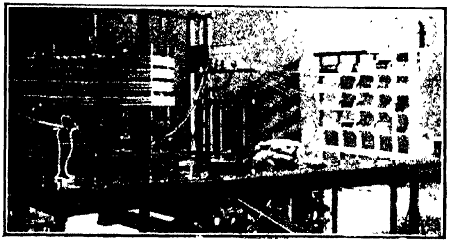


FIG. 88

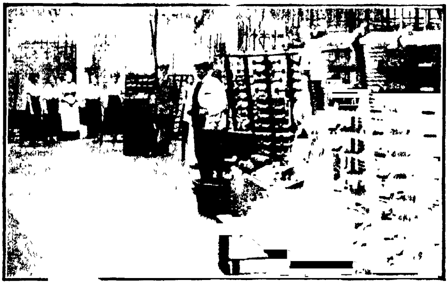


FIG. 89.

only on the mill, about 12 yards. The loose lease band is seen clearly at the pegs where the beamer's lease is made, whereas the thread-by-thread lease band is intact, having been wrapped round all the threads, and fixed as already indicated. The chain is linked off, as in the warping woof, by starting at the top after making the slight adjustments which are fully explained in the above-mentioned works. In both illustrations in Figs. 87 and 88 a completed warp or chain appears on the table. A view of a modern warping mill that appears in Fig. 89. Several warpers, with three large warping mills behind them, appear in the background, while a few banks belonging to other mills are shown on the right-hand side.

It is occasionally necessary, and perhaps often desirable, that all the threads of a warp shall be warped in the same direction; in other words, that there shall be no reversal of the direction of the groups in the manner which has been explained in regard to all the foregoing methods of warping. This "one way only" direction of warping presents the fibres of all the groups in the same relative position. In general, the operation necessitates that each group of threads shall be started at the pegs A, B, and C, and finished at the pegs D and E, Fig. 84. It is possible, however, to make comparatively short warps with all the threads in the same relative condition by the method illustrated in Fig. 90. The warp would be started, as usual, at the end peg on the left, and the first lease, thread by thread, made on the two upper pegs when warping the first group. All the threads of the group would be passed over the pegs as usual, the warper walking from side to side of the warping woof until he or she came to a point which represented half the actual length of the warp. All the threads would be passed over the peg at this point—the right-hand peg in Fig. 90—but no lease would be taken. The same journeys, but in the reverse direction, would now be made until the lease pegs were

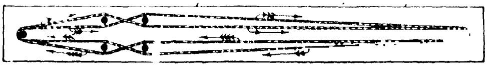


FIG. 90.

reached. A thread-by-thread lease, or perhaps a pin lease (beamer's lease) would then be made, and the threads arranged on the two lower pegs. Finally, all the threads would be passed behind the extreme left-hand peg, and the two operations repeated for the necessary number of times.

The arrows in Fig. 90 show how such a warp could be made from a single cop or bobbin. The first journey to right is indicated by a single-feather arrow. The next journey to left and terminating at the lower pair of lease pegs is indicated by a double-feather arrow. The third to the right from the upper set of pegs is identified by an arrow with three feathers, while the last journey to the left is represented by an arrow with four feathers.

When completed, the warp threads would be cut at the extreme peg on the left, and then split into one long length, of which the part on the right-hand peg would represent the middle of the warp.

If a group of threads were used instead of a single thread, the journeys would be performed in a similar manner. Thus, immediately before making the journey from top to bottom, or from left to right in Fig. 90, the weaver's lease would be made on the two upper pegs. In the reverse journey with the group the beamer's lease would be made on the two lower pegs. All the threads in the group would then be passed behind the left-hand peg, and the two journeys repeated for the necessary number of times – that is, until the total number of threads in the warp appeared on each pair of lease pegs.

A chain, long or short, and warped by any of the methods described, is most suitable for subsequent work when there is a lease at both ends, as explained in the foregoing description. It is not absolutely essential that there should be a lease, but, if it is omitted, it is necessary that some other arrangement should be adopted to preserve, as far as possible, the relative positions of the threads, so that the further preparation of the warp for the loom can be conducted without hindrance. As a matter of fact, it is not an uncommon practice in factory work to omit the making of a lease, and to substitute a method of gripping the straight sheet of threads in the warping or dressing machine by two rods which are provided with a kind of mortice and tenon, and between which all the threads are held secure by binding the ends of the rods. This pair of rods often receives the name of "clasp-rods" (see *Jute and Linen Weaving*, Woodhouse and Milne, 2nd edition, pp. 105 and 108). At its best this method is a poor substitute for a proper lease; it has the advantage, however, of being quickly made, and of simplifying the operation when a large number of threads is involved; when carefully performed, and the threads selected with equal care, the resultant crossings in the loom are not excessive. Nevertheless, it may be taken for granted that the substitution of any other method of arranging the threads in consecutive or approximately consecutive order for that of the thread-by-thread lease is done, not with the object of improving the relative order of the threads, but for other reasons.

CHAPTER VI

BEAMING OR WINDING-ON THE WARP

There are several ways of attaching the end of the warp containing the beamer's lease to the weaver's beam. One method extensively adopted in connection with power-loom weaving, and which might in some cases be employed in connection with hand-loom weaving, consists of the arrangement displayed in Fig. 91. This illustration, for simplicity only, represents a miniature beam, so far as the length or width of the beam is concerned, and a very short length of warp. By exhibiting a short length, one is able to show both ends of the chain or warp as well as the scheme adopted to run the last few yards of warp of any length on to the beam.

The pin lease or beamer's lease D, E, shows that the threads are leased in fours, whereas the weaver's lease C, B, is the usual thread-by-thread lease. The stretch of warp between B and A is for the purposes already mentioned. The thick rod A, and the two pairs of lease rods B, C, and D, E, control the threads of the warp in practically the same way as the five similarly lettered pegs on the warping woof in Fig. 84, or the pegs of the warping mill in Fig. 87.

The particular way of attaching the threads to the tube F of the weaver's beam in factory work seldom requires the use of the beamer's lease; it is required, however, when the warp has been made on a warping mill or by any other method where the warp is not intended to be dressed or slashed. The beamer's lease is introduced in Fig. 91 to show that if such a

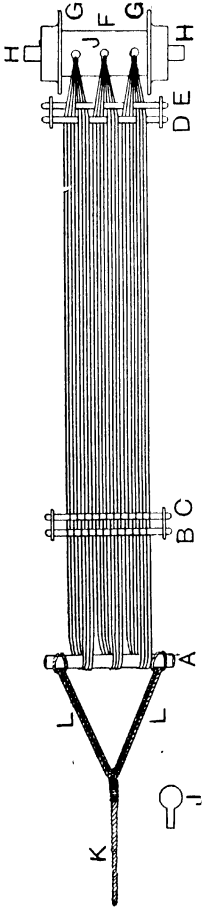


Fig. 91.

method were adopted for hand-loom weaving, the end of the warp with the beamer's lease, instead of being made with two pegs, would probably be more suitable if a third peg were used to make a similar but shorter stretch than that represented at the other end of the warp and between the pegs A and B. In general, however, the body of the weaver's beam is made of wood. For long warps it is usual to employ what are known as "loom beam flanges" G in order that the threads may be built up in cylindrical form. The ends H, for light work, are supported by brackets on the loom, and on which the beam moves very slowly round as the cloth is being woven.

Along the tube F of the beam are several openings J, the shape of one of which is shown detached to the left of the diagram, and on a larger scale. It consists, as shown, of a circular hole and a narrow slot.

Let us imagine that the warp is a short one; that the rope K has been attached by means of the thinner cords L to the stout rod A as shown, and the thick rope K secured to some fixed part; also that a similar stout rod had originally been inserted in the same opening as the lease rod E, and that the ends of this stout rod were supported by cords which passed over the weaver's beam or over the base of the flanges G. If the warp in this position were comparatively slack, it is evident that each group of eight threads could be cut behind the stout rod near the beam, a knot tied on the eight threads, and the knot then pushed through the circular hole of the opening J. Finally, the threads would slide into the slot of the opening J with the large knot under the slot. Each group of eight threads, or other suitable number, would thus be held securely in position, but each group should be tied to secure uniformity in the length or tension of the threads from side to side of the warp.

The rods D, E, which during this work are kept in position by fibrous lease bands or else by leather strips, would now be removed—if a thin twine is used instead of rods it is sometimes allowed to remain—and the weaver's beam rotated by some means until the stretch of warp nearly up to the lease rod C is wound on the tube F of the beam. The warp is kept taut during this operation either by holding the rod A or the rope K. This done, the cords L are loosened, the rod A removed, but the rods B, C, remain with the warp which is now ready for the next operation—drawing in, tying on, or twisting in.

The operation just described is unaccompanied by any reference to the method of supporting the beam, because we wished to illustrate the connection of the two ends of the warp in the simplest manner possible.

We might now consider different methods of attaching the end of the warp to the loom beam for hand-loom work, and also for certain types of power-loom work; in this connection we shall illustrate the beaming of a long warp in, say, a garret or similar room.

Let the oblique beams A, Fig. 92, represent the lower parts of two light rafters, and B, C, and D three stout beams, each of which bridges the gap between,

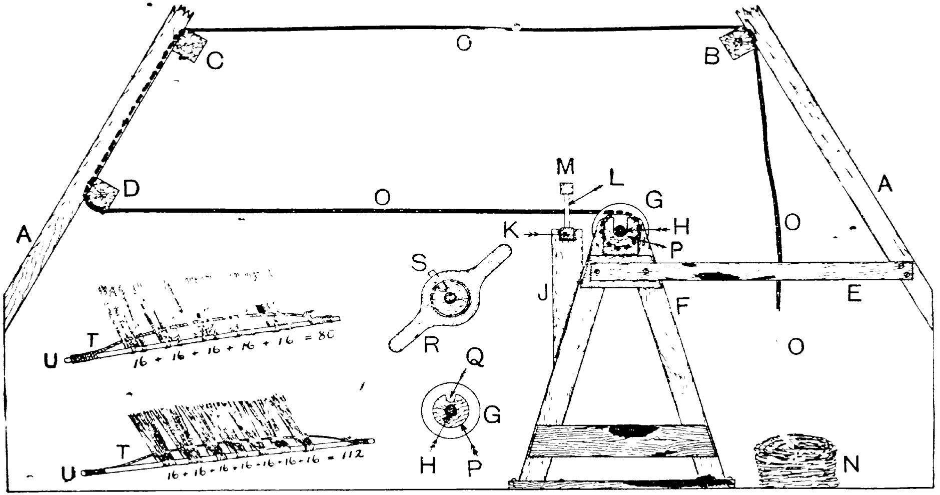

A
C
O
B
A
D
O
M
L
G
K
H
P
O
S
J
E
F
T
16 + 16 + 16 + 16 + 16 = 80
U
R
Q
O
G
T
16 + 16 + 16 + 16 + 16 + 16 + 16 = 112
U
H
P
N

FIG. 92.

and is firmly attached to two adjacent rafters on their respective slopes. One end of a batten E is fixed to a rafter or other suitable stationary post, and the other end is fixed to a trestle F; the latter in turn is secured to the floor. A second trestle is provided and similarly fixed to the floor at the required distance from the one illustrated. A recess is formed in the top of each trestle F to hold the gudgeon or end H of the loom beam, one of the flanges G of which is shown in the figure. An upright block J is fixed to each trestle F, and the upper ends arranged to hold securely the evener or raddle K, which is provided with a number of pins L and a removable cap M. The chain or warp, linked as described, is represented by the bundle or bunch N, and the number or group of threads O, which constitute the warp, is first passed over the beam B, then across the upper part of the garret and over the beam C, then downwards and under the beam D, and finally taken across the "stretch" D, M, and attached to the weaver's beam P in some satisfactory manner.

It only remains now to make some arrangement for turning the weaver's beam P clockwise, while holding the warp about the point O above the batten E, in order to beam or wind on the sheet of threads evenly and tightly on the boss of the beam P. A groove Q (see the lower detached figure near the trestle) may be cut in the beam, or a short piece of metal tube inserted, so that a simple winch R (see higher detached figure) may be connected to the beam by a pin S and used as a kind of double crank or handle. A single crank R, with handle as illustrated in Fig. 93, might be employed. Another very simple method is to double a rope or cord, fix or tie the loose end firmly to the loom beam, and then wrap the remainder clockwise round the beam; a rod can now be inserted into the looped or doubled end so that the rod may bear against the

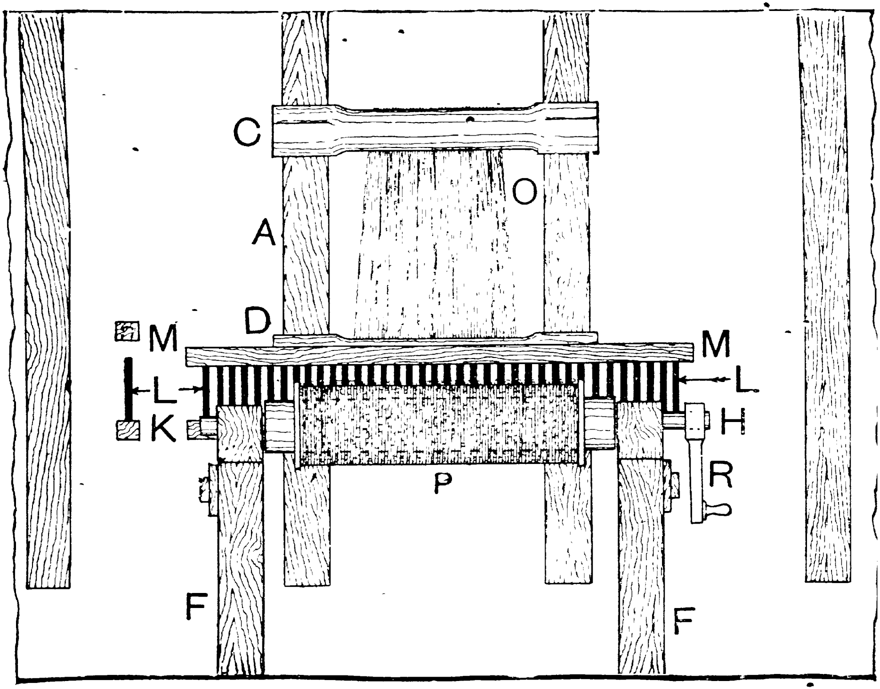


Fig. 93.

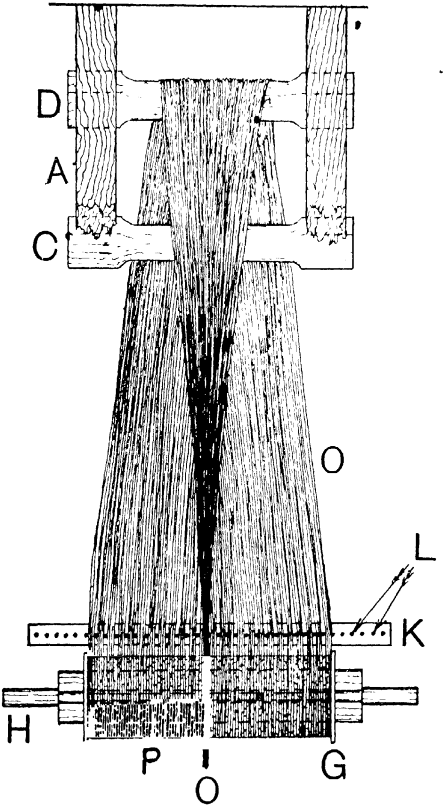


Fig. 94.

beam, the other end of the rod can be used as a handle or lever, and the beam rotated in virtue of the pressure on the rod being communicated to the looped cord, and hence to the weaver's beam.

Figs. 93 and 94 are different views of the simple beaming frame. Thus, the former is a front elevation of the trestles F, the weaver's beam P, and the evener or raddle K. The sheet of threads has been cut off as indicated, so that the stretch between the beams B and C, Fig. 92, would not interfere with the illustration of the warp beam and evener. In Fig. 94, however, which is a plan view, the gradual opening out of the group of threads O, due to the distribution of the threads amongst the pins L of the evener K, is apparent. It will be seen that there are four threads between each pair of occupied pins L in both figures. In Fig. 93 there are 22 openings filled, and hence the warp contains 22 × 4 = 88 threads; in Fig. 94 there are 25 so-called "pinfuls," and hence 100 threads in the warp.

Returning to Fig. 92, the two detached views on the left illustrate one method of preparing the beamer's lease end of the warp ready for being attached to the weaver's beam. A piece of twine T is fixed to the left-hand end of an iron rod U, about $\frac{3}{8}$ in. in diameter. The free end of the rod U is passed through the end opening of the beamer's lease—that originally occupied by the lease pin E, Fig. 84—while the twine T is passed through the other opening which was occupied by the pin D in the same figure. The end of the twine T is now fixed to the right-hand end of the iron rod U, as shown. In the upper detached view in Fig. 92 there are evidently five groups of 16 threads (5 bouts, with 8 threads in the bank, or 10 half-bouts of 8 threads and leased in fours); while in the lower detached view there are seven groups of 16 threads, or 112 threads in all, and leased singly to form the thread-by-thread lease.

The rod U and the twine T are invariably inserted, and the rod held in position, as explained in reference to the short warp in Fig. 91. And while the warp is held thus in loose suspension, the various groups of threads, or "pinfuls" (four in the upper detached view in Fig. 92), are deposited successively in the openings between the pins of the evener or raddle. If the pins of the evener are fixed, that is, incapable of being moved laterally so as to alter the distance between each pair, the number per pinful must be calculated so that the occupied openings of the evener may be equal in width to the distance between the flanges G of the loom beam P (see Figs. 93 and 94). If, on the other hand, an adjustable evener is used, the same precautions are unnecessary. (See *Jute and Linen Weaving: Mechanism*, Woodhouse and Milne, 1st edition, pp. 35 to 37; 2nd edition, pp. 66 to 69.)

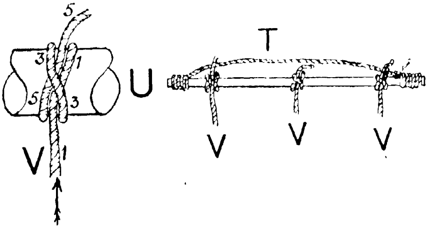


FIG. 95.

When all the pinfuls have been arranged, the iron rod U is placed in the longitudinal groove Q of the loom beam P, Fig. 92, and secured there by means of a number of cords V, as exemplified in Figs. 95 and 96. The left-hand part of Fig. 95 is an enlarged view of part of the iron rod U, and illustrates how the free end of the cord V is arranged around the iron rod U. It will, of course, be understood that the other end of each cord V is securely fixed in some way to the loom beam, and that there are a few rounds of such cord at each place in order that the end of the warp may approach as near as possible or practicable to the healds during weaving, and thus minimise the length of waste between the last shot or pick of weft in the cloth and the end of the warp; it is obviously impossible to weave this length, which, with a small part of the woven cloth, say one to three inches, is known as a weaver's "thrum."

The few rounds of cord, which it is found desirable

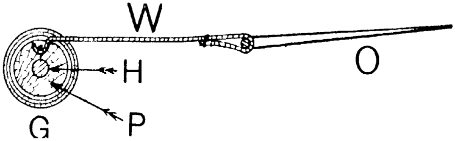


Fig. 96

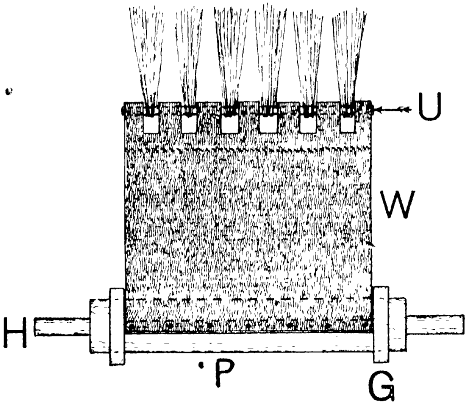
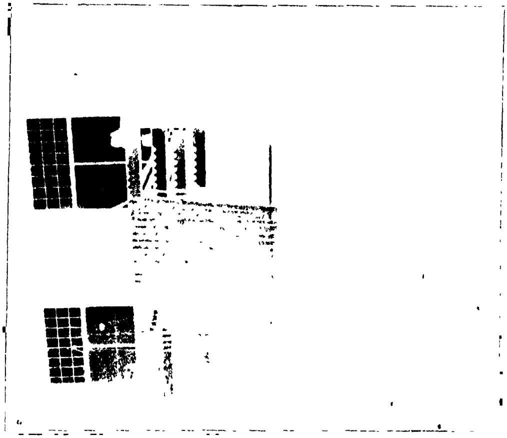


Fig. 97.

to utilise in order to prevent a larger length of waste than that just mentioned, introduce a defect in that the last layers of warp which cover these cords are obviously longer than those which are wound round the bare beam, and since both these groups are ultimately woven simultaneously, there is a tendency for



[illegible]

the threads which form the longer layers to " weave slack," as it is termed, and to present in the cloth a different depth of colour from the remainder of the threads; in other words, a " stripey " effect appears in the cloth.

This defect can be prevented by nailing a width of cloth W, Figs. 96 and 97, in the groove Q of the loom beam P; the other end of this cloth is doubled over and sewn to make a wide seam, and then rectangular pieces are cut out as shown. A rod U, similar to that already mentioned, is passed through the opening of the seam, and through the loops of the beamer's lease, or else the threads are tied to the rod in the rectangular gaps. The length of cloth W is sufficient to allow the end of the warp to pass over the back beam of the loom, and all the threads are approximately the same length. Patented methods, which include such a length of canvas cloth and neat attachment links, have been in vogue for a great number of years.

Figs. 98 and 99 illustrate respectively the back of a modern beaming frame, and the main parts of the front of the machine. It is used for beaming chain warps on to weavers' beams, and the latter figure shows the sheet of threads passing through the evener or raddle, and on to the loom beam. The ends of three chains—all going on to the same beam—are also seen depending from the tension bars, while the continuation of the warps can be seen in the upper part of the illustration. They pass across the upper part of the " stretch," and over one or more of the " spreading " bars (Fig. 98), then downwards and under a roller, and again bridge the gap between the back and front sections of the frame to enter the evener, as already mentioned.

CHAPTER VII

GOBELIN, ARDEBIL, AND ORIENTAL FABRICS

IT will now be quite evident that, except under very exceptional circumstances, the production of fancy fabrics where the ornament is due mostly to the method of interlacing the weft threads with the warp—can be accomplished only by complicated mechanism, or by a tedious process of combining a method of simple weaving with some type of hand selection. On the other hand, extremely rich and artistic textures can be and are made by means of comparatively simple structures when combinations of different coloured yarns are employed.

Illustrations of fabrics with surfaces of simple geometrical figures have already appeared in the production of which only the simplest type of apparatus was used, and where no actual hand selection was essential. More advanced types of ornamental fabrics have also been illustrated, in which the ornamentation was obtained by means of similar simple shedding apparatus, but where each line of weft was composed of one, two, or more colours, and in lengths which corresponded to the configuration of the design.

Different types of looms or frames have been illustrated for the production of these fabrics; no sharp dividing line appears to exist as to the employment of horizontal and vertical looms, but, in general, the elaborately figured designs appear to be made largely on the vertical or *haute-lisse* loom, whereas the simple types are often made on the horizontal or *basse-lisse* looms. The vertical arrangement offers more facilities for the weaver to compare his or her work with the copy, if and when a copy is used, as well as simplifying certain manual operations, particularly in the manufacture of pile fabrics.

Perhaps the finest specimens of the weaver's art, so far as the simple frame process is concerned, are the Oriental rugs and carpets, and the somewhat similar textures which are made on almost identical frames by one or two well-known British firms. In these cases, however, the ornamentation is obtained solely by using yarns of different colours and displaying these yarns by some simple structure according to the massed effects of colour in the design. The ground or foundation of these fabrics is made almost invariably with the plain weave, while the design or colour scheme is developed by means of short lengths of wool, silk, or worsted yarns, usually the former, and in such a way that all the ends of these short lengths are visible on, and constitute the upper surface of, the texture. This type of structure is known technically as pile, plush, or velvet weaving. (For a full description of these types of weaving, see *Textile Design: Pure and Applied*, T. Woodhouse and T. Milne, pp. 360 to 440.)

The famous Gobelin textures of the Savonnerie type are similar in structure to the Persian rugs in that the effect is obtained by pile weaving with variously coloured yarns, whereas the Aubusson Gobelin is flat weaving and known as "tapestry." The word tapestry is rather an elastic one, for it includes not only a great variety of cloths which are actually woven by hand and by power, but several textures in which the ornament has been displayed by a process of sewing or embroidery. Take, for example, the world-famous Bayeux tapestry, the construction of which has been credited to Queen Matilda; the foundation or body of this so-called tapestry consists of about 230 ft. of 20 in. wide brown linen, and the ornamentation on it is supposed to depict the Conquest of England. Animate and inanimate forms abound throughout the full length of the fabric, and these forms include 623 human beings, 762 horses, mules, dogs, and other animals, 37 buildings, 41 ships and boats, and 49 trees, or, altogether, 1,512 distinct illustrations in eight different colours. Not one of these forms or figures is actually woven, but all have been introduced by the aid of needles or similar instruments. The word tapestry for such a fabric is, therefore, a misnomer, but the work is distinguished by this word, and hence it will probably always be known as a tapestry.

On the other hand, the ground and ornamentation in the Gobelin and other similar tapestries are formed, as it were, simultaneously from warp and weft yarns; but here, again, the actual work is one of hand selection, and the process may, therefore, be considered as a particular type of sewing or embroidery.

With almost equal justification one might say that all the Oriental rugs and carpets, the Savonnerie type of Gobelins, as well as all others made by similar processes, are, in reality, incorrectly styled woven fabrics, for all of them are made by a process of hand selection, even when the operative is forming the simple groundwork of the structure.

It is, of course, difficult to draw a hard and fast line between the various modes of working, but, in our opinion, no texture can truly be said to have been actually woven unless the threads of which the warp is formed are operated collectively according to the desired method of interlacing, and a shuttle or shuttles, or other weft carrier, used to carry the weft either wholly or partially across the width of the fabric.

Although it is possible to obtain by mechanical means the same diversity of effect which is achieved by a system of hand selection, it is, in general, impracticable; but a sufficiently varied effect can in most cases be obtained by weaving, and the fabric is certainly made much more quickly and at less cost than by any scheme of hand selection. The great advantage of hand selection is that it is practicable to make

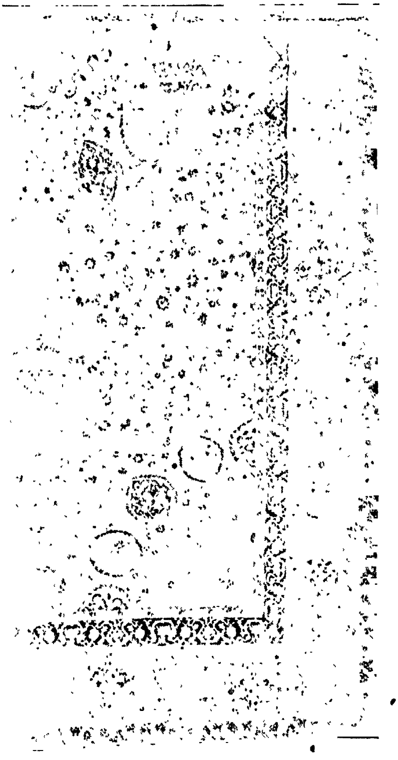


FIG. 100.

exclusive designs, and that the cost of making a hundred cloths, each differing in design, does not differ sensibly from the cost of making a hundred cloths of the same design, provided that the amount of detail in all is approximately the same. When, however, it is necessary to produce cheap fabrics, duplication by actual weaving is essential, but, although the cost per cloth or yard is low for such mechanically manufactured goods, it does not follow that the textures lack beauty of design, taste in colour, quality of fibrous material, or perfect workmanship.

What is often considered and styled the most wonderful piece of weaving that has ever been accomplished is the "Ardebil Carpet," approximately one-quarter of which is illustrated in Fig. 100. This carpet, which is termed the "Holy Carpet of the Mosque at Ardebil," and which is now housed in the Victoria and Albert Museum, South Kensington, measures 34 ft. by 17 ft. 6 in., and has been valued at about £6,000. It is the Persian masterpiece, and, according to history, was woven by Maksoud, the slave of the Holy Place of Kashan, in the sixteenth century for the tomb of Sheikh Ismael. It has been stated that from start to finish the task occupied 34 years.

In addition to the warp and weft threads which form the actual ground or foundation of this fabric, there are more than 32,000,000 hand-tied tufts, or nearly 400 to the square inch. The design, which is rich in detail, is practically symmetrical in both directions, and hence the section reproduced illustrates approximately all the ornamentation and gives an excellent idea of the design. The illustration loses much of its value, however, in the absence of the actual colour scheme, the rich effects of which may be seen in the fabric or in the monograph published in folio, by Edward Stebbing, London, 1893.

Fig. 101 is a reproduction of a very fine antique

Kirman rug, and is the property of S. J. Waring, Esq., of Messrs. Waring and Gillow, Ltd., Oxford Street, London. This firm has kindly supplied the author with illustrations from which Figs. 100, 101, and 102 have been made. The border in Fig. 101 has a wealth of fine detail which contrasts well with the much bolder type of ornament in the field. No half-tone

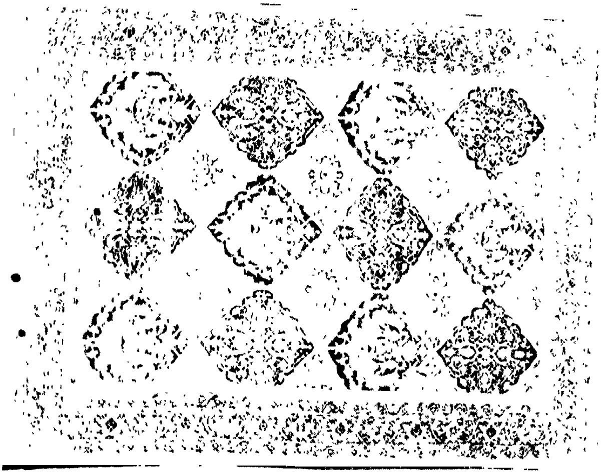


Fig. 101.

reproduction can do justice to the rich, mellow effects which constitute a characteristic feature of the actual colouring of this example.

A modern British reproduction of a Kirman Axminster carpet, or, rather, about one-quarter of the complete seamless carpet, is reproduced in Fig. 102. The design is copied from a fine example of Persian art, and the original carpet was sold for upwards of

300 guineas. The colour scheme of the carpet is excellent, and the general effect reflects credit on the producers.

No description of mechanical weaving by power is to appear in this work, but it is only fair to state that practically any scheme of coloured carpet or rug can be obtained mechanically, and, of course, at a much lower cost per article than by the hand selection method, provided that a sufficiently large number is made.

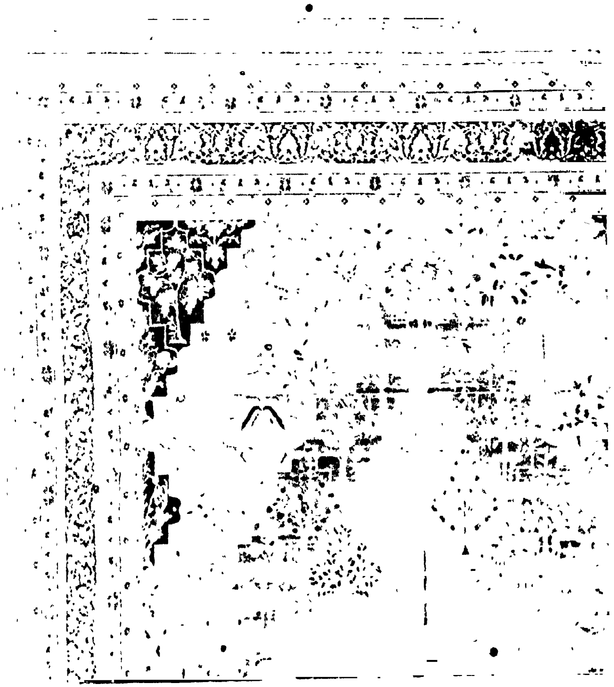


FIG. 102.

CHAPTER VIII

THE WEAVING OF PERSIAN, DONEGAL, AND REAL AXMINSTER RUGS AND CARPETS ON LARGE FRAMES

THE general principles involved in the making of a warp or chain, and in the so-called operation of weaving, having been described and illustrated, we shall now return to the consideration of frames or looms which are utilised for the actual manufacture of fabrics on a commercial scale, and shall describe the actual operations involved in the weaving of these works of art.

In the first place, it should be mentioned that the vertical loom is usually employed in connection with the manufacture of these elaborately coloured rugs and carpets. The loom, or, rather, frame, is in most cases very crude, as exemplified in Fig. 103, which represents five females at work under the superintendence of a sixth person, in one of the establishments of Messrs. Ziegler and Co., The Persian Gulf Trading Co., of Sultanabad, Teheran, and other Persian towns.

The loom consists of four beams and two rods—not a very formidable equipment for the production of such beautiful fabrics as emerge from them. Two stout vertical beams or posts are fixed in the ground, and a cross-beam is fixed on the top of these beams. Another cross-beam is adjustably fixed in slots in the vertical beams but near the floor. The warp threads are stretched as indicated between these two cross-beams, and they practically fill the space enclosed by the four beams, or main frame of the loom.

The warp is made in a very simple manner; two pegs are placed in the ground, the distance apart being equal to the length of carpet to be woven, plus the amount required for shrinkage during the operation of weaving. The warp is passed round these two pegs until the necessary number of threads has been stretched between them. At one of the pegs a so-called selvage is formed to keep the threads in their

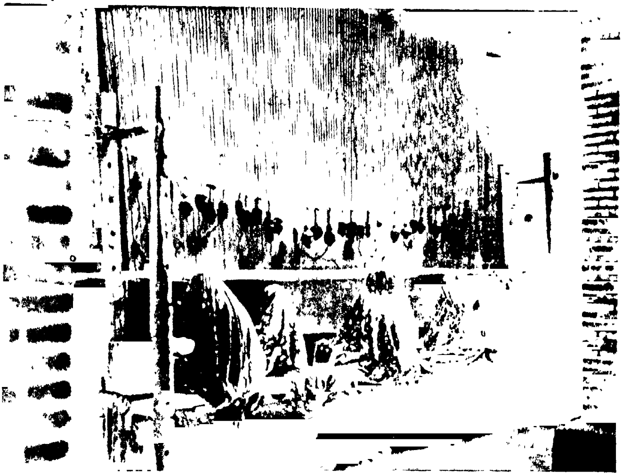


Fig. 103.

respective positions, and to facilitate the fixing of the threads to the equivalent of a cloth-beam.

When the warp is made, it is taken to the loom and passed over the top beam, as illustrated in Fig. 103, and also in Fig. 104, both photos of which were taken by Mr. Edward P. Hutton, a former student of the author. All the threads then hang down as shown on the right in Fig. 104, where the left-hand part of the so-called "warp-selvage" is in view near one of the beams, the cloth-beam at the foot.

The warp threads are now secured firmly to the lower cross-beam as demonstrated in Fig. 105. A stout rope is wound round the lower cross-beam, the rope being represented in Fig. 105 by the letter A; the warp selvage is shown at B, while the cord C indicates the method of attaching the warp selvage to the ropes A of the cloth-beam. The first few shots of weft are shown at D with one pair separated from the body; finally, the lower part of the warp threads is shown at E. The cord C is also shown on the cloth-beam in Fig. 103, immediately under the weaver's seat.

FIG. 104.

The four shorter vertical posts in Figs. 103 and 104 form the supplementary frame of the loom, and each post is provided with holes to receive iron support rods, on which the long seat for the weavers is placed. It will thus be seen that, as the weaving proceeds, the rungs of the crude ladder may be inserted successively in the holes to enable the seat to be raised to a convenient position for the execution of the work. In some cases the warp is made much longer than the stretch between the two cross-beams; in such cases the warp threads are wound on the top cross- or warp-beam, and the cloth wound on the bottom beam. The weaver then remains at the same level throughout the process. The remaining preparatory operations are explained in connection with Figs. 106 to 109.

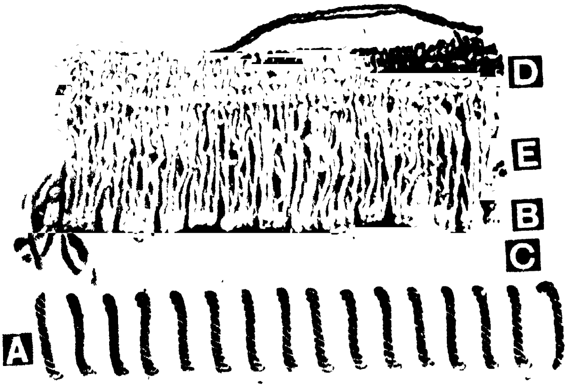


Fig. 105.

The parts A, B, C, and D from Fig. 105 are indicated in the lower parts of Figs. 106 and 107, while E and F represent the back and front set of warp threads. The top and bottom cross-beams or rollers of the loom are lettered G and H respectively.

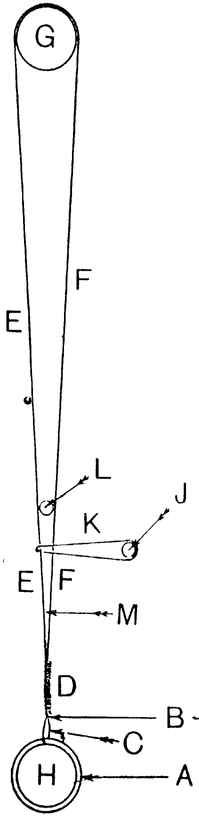


Fig. 106

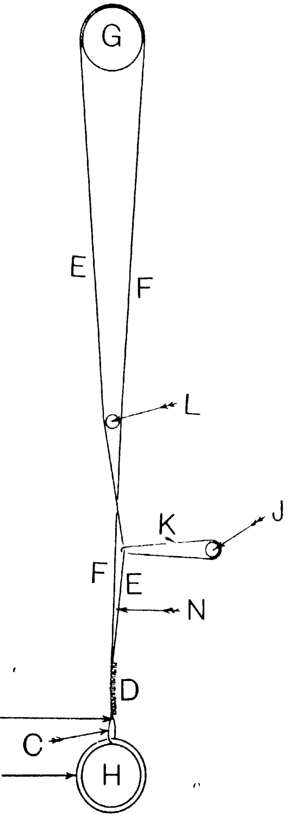


Fig. 107.

While the warp threads are hanging, as depicted on the right hand of Fig. 104, the operative makes preparations for picking the lease. A pole J, Figs. 106 and 107, is tied to the vertical beams—this pole is shown distinctly in Figs. 103 and 104, practically on a level with the heads of the weavers and a thread-by-thread lease is formed by passing a cord K, Fig. 106, round the rod J, then round the first thread of the group E, again round the rod J, forward between two threads of the front group F, round the second thread in the back group E, and back again between the same two threads and to the rod J. This operation is continued, each time moving one thread forward in the front group F, and passing the cord round the companion thread in the back group E, until a loop has been passed behind every warp thread in the group E. The loops K are about 8 in. long. A lease rod L is then passed between the two groups E and F just above the cords K.

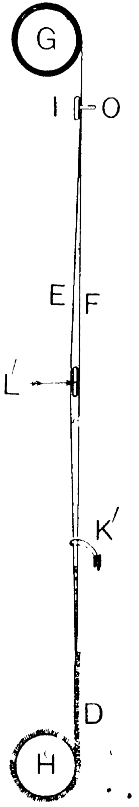


Fig. 108.

With the parts in the position indicated in Fig. 106, it is evident that a length of ground weft could be inserted into the "open-shed" at M, and that the next shot of weft could be inserted into the "crossed-shed" at N, Fig. 107, provided that the two groups of threads could be made to occupy the positions therein indicated. Similar remarks apply to the two necessary operations for the arrangement indicated in Fig. 108. In the latter case the warp threads E and F are wound or beamed round the upper beam G, the several layers or rounds being represented by the heavy black circle; the threads, say in pairs, are then passed between a series of pegs O in the bar P, and then down to the cloth-beam H. The rectangular bar L′ serves the same purpose as the round rod L in Figs. 106 and 107, while the hanging loops K′, Fig. 108, are used to perform the same function as the loops K in Figs. 106 and 107. As the cloth D is woven in the loom arranged as in Fig. 108, the warp-beam G is moved slightly round clockwise, and then the cloth-beam H is moved in the same direction until the threads E and F are at the desired tension. It will be understood that these two latter operations are not continuous, but intermittent, and they are performed when the weaver thinks it is desirable to do so.

When the lease has been picked in the looms illustrated in Figs. 104 to 107, the threads of the warp, or, rather, the warp selvage, Fig. 105, is attached to the ropes A of the beam H by means of the cord C, and then all is drawn tight by inserting wedges Q, Fig. 109, into the slots of the vertical beams R, and above the lower cross-beam H. After having driven up the wedges Q, all is ready for the actual weaving operation. The part lettered S, Fig. 109, represents one of the corners of the cloth.

The usual kind of Persian and similar carpets and rugs has a structure which necessitates three distinct series of threads. These are:

(1) The foundation or ground threads.
(2) The foundation or ground picks.
(3) The pile or figuring tufts.

Although it is possible to make carpets, rugs, or the like in which all the tufts are of the same colour, and thus produce a self-coloured fabric, the more general practice is to employ a comparatively large number of different coloured yarns for the pile, in order that designs of any practicable nature can be reproduced on the surface of the cloth. These coloured yarns are placed within easy reach of the weaver, because a considerable part of the time is occupied in the dual process of selecting the correct colour of yarn and introducing it into its proper place in the fabric.

In Figs. 103 and 104 the coloured yarns are shown as

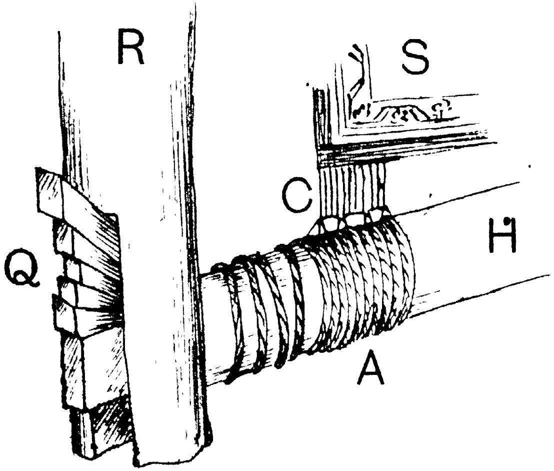


FIG 109

having been wound into a kind of ball, and hung upon a cord which is stretched between the two main vertical posts, and in a convenient position for the weavers. In other cases a wooden bar with projecting pins or pegs occupies a somewhat similar position to the cord of balls, and bobbins of coloured yarn are supported by the pegs upon which the bobbin may rotate when the weaver pulls the thread ready for inserting it to form one of the figuring tufts. A further method is to have the coloured yarns cut up into short lengths according to the length required for the production of the necessary height or depth of pile. These coloured bits are placed into boxes, in which a separate compartment is provided for each colour.

Such boxes for the pile weft are shown distinctly in Fig. 110, which illustrates several weavers at two rows of looms making the famed Donegal carpets. The arrangement of the warp threads on the upper beam, and between the pegs of the peg-frame for preserving the respective positions of the threads, is on the same principle as that demonstrated in Fig. 108. An enlarged view of sections of the few similar looms appears in Fig. 111. In this illustration the short lengths of tufting weft are seen distinctly in a few compartments of the box between the first two weavers. Figs. 110 and 111 are reproductions from photographs made from negatives supplied to the author by Messrs. Alexander Morton and Co. (Morton Sundour Fabrics Ltd.), Darvel and Carlisle. The negatives were made in one of their Donegal factories, Killybegs, Kilcar, Crolly, or Annargry.

It has already been shown, Figs. 103 and 104, that a rod is used in conjunction with a series of twines to form one of the sheds or openings for the ground or foundation weft. In the looms illustrated in Figs. 110 and 111, however, the corresponding operation is performed by similar twines tied together in groups, thus forming handy bunches for the weavers; these bunches, the constituents of which are identical with that shown at K′ in Fig. 108, are shown clearly in Fig. 111, on a line with the heads of the weavers. Immediately above these bunches is a design, or, rather, a section of a design, since two, three, or more operatives work at the same carpet, and from this sectional design the weaver sees what coloured pile weft has to be inserted across her width of threads. The

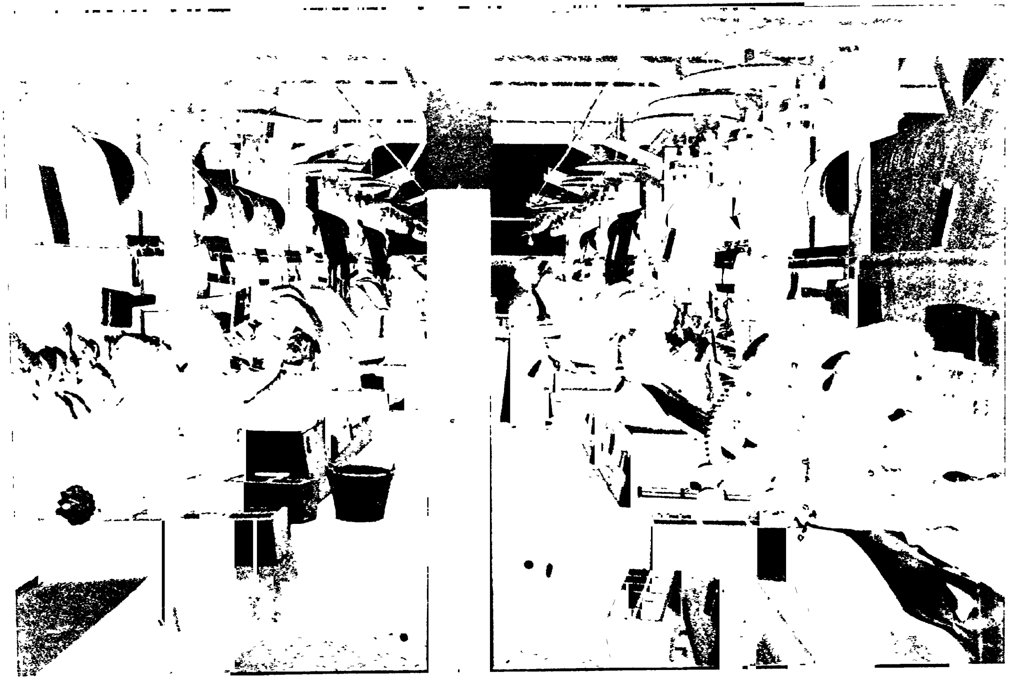


Fig. 110.

width of threads under her charge corresponds to the sectional design from which she works, each pair of warp threads in her section being represented on the design paper by one vertical row of small squares, or, rather, by the various colours in the row of small squares. For example, the design on the rug in the foreground, and on the left of Fig. 111, is identical in outline with the design on point paper just above the bunched loops. The methods of forming the pattern on the cloth will be illustrated and described shortly: in the meantime, we might describe the process of forming the foundation of the fabric.

FIG. 111.

It is customary so to arrange the warp threads that when in their normal positions they shall form two layers, which converge to the "fell" of the cloth, i.e. the last inserted pick of weft, and so constitute one of the so-called "sheds" or openings for the weft. When so arranged, all the odd-numbered threads, 1, 3, 5, 7, etc., are, say, at the back, as represented by the letter E in Fig. 106, and all the even-numbered threads, 2, 4, 6, 8, etc., would then be at the front as indicated by the letter F in the same figure. The disposition of the yarns into two layers provides a condition which makes it a comparatively easy matter to insert a length of ground weft into this "open shed" M. The weft is inserted by hand, although some simple weft carrier might be used if desired.

When this full-width pick of weft is in its position, the lease rod L is raised to the position indicated in Fig. 107. The second plain pick is not so easily entered into its shed as is the first pick, and the lease rod L is raised to assist in, or, rather, to provide sufficient length of warp for, the formation of the shed during the more difficult operation. The weaver places her hand flat on the threads about midway between the points L and K in Fig. 107, and presses on them in order to force the front layer F as far back as possible, and simultaneously pulls the rod J towards her so that the cords K may draw the threads E which are normally at the back to the front as illustrated in Fig. 107. The second shed N is thus formed sufficiently big to allow the hand of the weaver to wriggle through and to insert the weft. In looms constructed on the principle of those illustrated in Fig. 108 and in Figs. 110 and 111, the second shed is formed by pulling the bunched cords K′, but otherwise the principle adopted in the two styles of loom is the same. When the rod or bunch is released, and the lease rod L is lowered, the threads again assume the positions indicated in Fig. 106.

In general, one complete horizontal row of tufts, and two such plain picks, constitute one cycle or round of the weave; in special cases each row of tufts is accompanied by four, and occasionally by six, ground picks, that is, two or three pairs of the simple ground weave. After the insertion of the last ground pick in the above cycle of three, the two ground picks are "beaten down" by a kind of hardwood or iron comb—a multi-pronged instrument. The weavers nearest the observer in Figs. 110 and 111 are performing this operation, and a more elaborate form of beater is shown on the floor in Fig. 103. The weaver on the left in Fig. 110 is inserting one of the pile tufts, an operation which is described below. The row of tufts is, of course, beaten down at the same time, so that it may join the row which was inserted in the preceding cycle. In power-looms, and in ordinary hand-looms, the operation is termed "beating up," and it is performed by a reed operated mechanically or manually, as the case may be.

METHODS OF INTRODUCING PILE.

The method of introducing the pile yarn or tufts in carpets and rugs differs in the various seats of manufacture. This difference may arise partly from the effect desired, partly in virtue of custom, and partly in regard to the various thicknesses of the yarns compounded in the manufacture. There may be two, four, or more ground picks for each complete line of tufts or pile picks; occasionally there may be an odd number of ground picks, but the general practice is to insert them in pairs, and often, as already mentioned, one pair of ground picks after each line of pile. In any case, if there are more than two picks of ground, the additional pairs are simply repetitions of the first pair, and hence need no further description.

EXAMPLE OF PERSIAN RUG.

A small section of a Persian rug or carpet is reproduced in Fig. 112. The ground warp is 5-ply white cotton, and the lower part of the illustration shows clearly the commencement of the rug with about 2 in. of the white warp as a fringe. Next comes about four shots of the 3-ply blue cotton ground weft, introduced to obtain a comparatively horizontal line for the

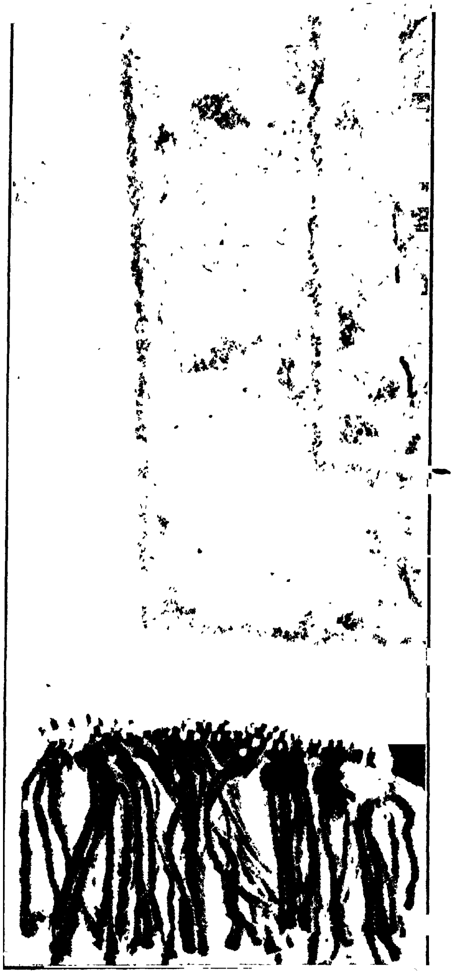


FIG. 112.

insertion of the first line of pile, and to provide means for making perfectly horizontal lines, where such lines are desired in the design, and there are invariably such lines near the outer edges of the fabric. About 1 in. of a band of dark blue pile would surround the complete structure, and part of this will be seen distinctly on the right and immediately above the above-mentioned ground picks. Inside this dark outer band is the outer border of the rug, and in the present case the width of this border is about 1¾ in. Then, after two narrow horizontal and vertical lines, comes either the inside border or the field or filling of the texture.

COLOURS EMPLOYED.

The colours used in the sample illustrated in Fig. 112 are as follows: Dark blue, terra-cotta, pale blue, mid-green, sage, and fawn. All these colours, and the relative length of the pile, are represented by the short doubled tufts of pile which have been taken from the fabric and exhibited in the upper part of Fig. 113. Immediately below these tufts of wool pile is a length of the 3-ply blue cotton weft; then comes a length of the 5-ply white cotton warp; and, finally, a small cutting of the fabric to show how the thick and substantial selvage is made. This view will be referred to again shortly; in the meantime, we shall discuss the formation of the pile, which is the characteristic feature of the fabric.

METHODS OF SELECTION.

There are two distinct methods of selecting the pile threads. One method consists in taking small prepared lengths of the necessary colours from a box. In the other method the weaver has a ball or bobbin for each colour of tuft yarn required for the proper colour scheme of the structure. The finished result, however, may be the same in both cases.

CONSTRUCTION.

Consider, for example, the illustrations in Figs. 114 and 115. In the upper drawing, marked A, we illustrate, in four stages, the formation of one so-called knot or tuft, and in connection with four pairs of warp threads marked 1, 2, 3, and 4. It will be understood, however, that in actual work there is a

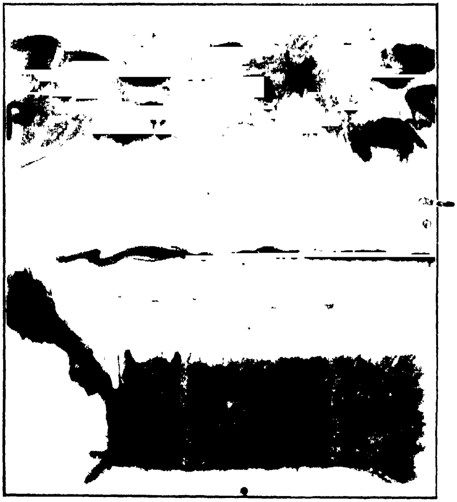


FIG. 113.

finished tuft for each pair of threads. At B, Fig. 114, we illustrate the formation of a similar knot also in four stages. No ground or foundation picks are shown in drawings A and B; these two illustrate respectively:

(A) The method of using short lengths of wool to make the pile or tufts.

(B) The method of utilising the yarn from a bobbin or ball to make the tufts.

In drawing A, and above the first pair of warp threads marked 1, the short length of wool for the

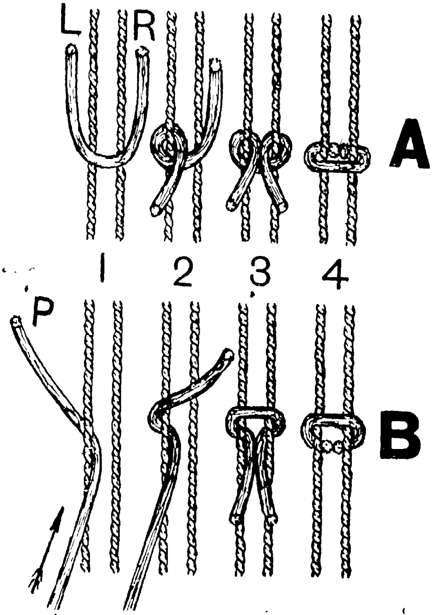


Fig. 114.

pile is represented by the U-shaped bit of yarn; the ends of this pile yarn are marked L and R to indicate left and right.

In the sketch above the second pair of warp threads marked 2, the left-hand branch L of the pile has been passed under the left-hand warp thread of the pair 2, and then brought upwards between them to the surface. In connection with the third pair of warp threads 3, the right-hand branch R has been passed under the right-hand warp thread of pair 3 and then brought to the surface between the pair of warp threads. Both loose ends L and R are therefore situated between the pair of ground threads. When this tuft, and all others of a similar kind, are beaten

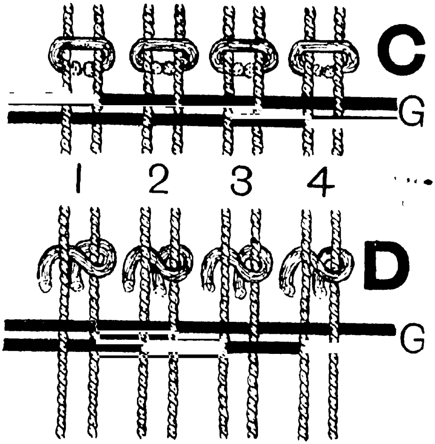


FIG. 145.

into close contact with the last line in the unfinished carpet, they will appear very much like that represented in connection with the ground threads marked 4. The pile threads, that is, the ends L and R, will stand more or less erect, and the middle part of the tuft will cross the pair of warp threads from above as indicated. In practice, the left- and right-hand branches L and R of the U-shaped tuft are threaded simultaneously from the outer edges of the pair of warp threads, and brought upwards between the same pair.

The fabric is made by starting at the bottom and proceeding upwards; hence, although the method at A indicates the ends L and R of the tufts in their correct position, it will be noticed that they form, as it were, the fell of the cloth. It is better, however, so to insert the ends L and R that they will be held between the central part of the tuft and the last ground pick; in other words, that the U-shaped length should be inverted in order that the ends L and R may be threaded towards the operative instead of away from her or him. Thus, instead of the finished tuft being represented as in A with regard to the warp threads 4, it should appear as shown at C, Fig. 115. In this view there is a tuft for each pair of warp threads, and it will be clear that when the heavy comb is used to beat up the tufts, the ends L and R will be locked, as it were, between the central part of the tuft and the two ground picks G. It will, of course, be understood that the next pair of ground picks will, with the pair illustrated, grip securely all the tufts in that line.

Now, with regard to the drawing B, Fig. 114, there are again four pairs of warp threads illustrated in order to show the four stages in the formation of the tuft or pile. The pile thread P, coming from a bobbin or a ball in the direction of the arrow, is passed downwards between the two warp threads constituting the pair 1, and under the left-hand ground thread; it is then brought to the surface and crossed over the two threads marked 2; it is then taken downwards, as indicated in connection with threads 3, under the right-hand thread, and finally upwards between the pair of warp threads. The right-hand end of the tuft should be the correct length; the other branch is cut to the same length, and this leaves the free end from the bobbin or ball to be inserted for the formation of the tuft for the next pair of warp threads, provided that the design necessitates the same colour of yarn. The final appearance is, of course, as shown with the warp threads 4.

As before, when all the tufts have been inserted, the appearance will be as at C, Fig. 115. It will be seen that in the finished row there will be two pile ends between each pair of warp threads, but there will be an equal gap, or nearly so, without any pile end, e.g. the gaps between the pairs are empty.

If the pile threads are not sufficiently thick, or not set close enough, there is a tendency for a line to appear between each pair. The pile threads in the fabric illustrated in Figs. 112 and 113 are inserted as at D, Fig. 115. This arrangement places one pile end between each pair of threads over the full width, and thus secures a regular distribution of the pile ends. The pile threads from a bobbin or ball can easily be threaded as exemplified at D, for it will be observed that the free end of the thread passes under the left-hand warp thread, then up between the pair, over and under the right-hand warp thread, and again up between the pair of warp threads. A solid compact body of tuft is thus provided, and the selvage of the rug is made to correspond in colour to the outer band by wrapping a group of yarns around the last three warp threads; this group is shown distinctly on the left of the bit of cloth illustrated in Fig. 113.

A very common way to illustrate the threading of the tufts for carpets and rugs of the type under discussion is that in Fig. 116. At first sight the arrangement appears a little complicated, but a little consideration will reveal the fact that it is identical with the threading described in connection with drawing B, Fig. 114. Four ground picks, two pairs, have been introduced in Fig. 116, and the same number of pile threads and pairs of warp threads as in Fig. 114.

The carpet illustrated in Fig. 117 is interesting, not only because of its size, but because of its destination. The carpet is one of the unique products of the Wilton Royal Carpet Factory Co., Ltd., near Salisbury; it is 60 ft. in one direction and 50 ft. in the other, and was made for one of the floors in Buckingham Palace. The structure is known as "Real Axminster." All the ground of the carpet is in deep cerise, the festoon border is developed in shades of French grey, while the extreme outer border or band is a dark cerise. All the tufts were inserted separately by hand, and by female weavers, several of whom are in the background of the view, and immediately in front of two blocks which form part of the buildings in connection with the works.

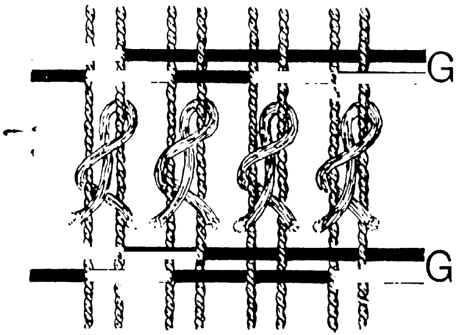


Fig. 116.

The fabric exhibited in Fig. 117, and similar fabrics made by the above firm, resemble closely the Oriental tufted fabrics. It is interesting to note that this type of weaving was commenced at Axminster, Devonshire, about the middle of the 18th century, and that the

manufacture of these high-class textures was transferred to Wilton about the year 1835; since this date the industry has been conducted, without interruptions, in conjunction with the manufacture of Wilton carpets by power-looms. The men on the carpet in Fig. 117 are clipping off the loose and uneven ends preparatory to packing up the carpet for delivery.

CHAPTER IX

SMALLER FRAMES FOR USE IN THE WEAVING OF TUFTED AND OTHER FABRICS

THIS chapter is intended to show how the principles of weaving Persian, Donegal, real Axminster rugs and carpets, and so-called tapestries may be expounded to those who wish, for any reason, to experiment in handicraft weaving.

Fig. 118 is a photographical reproduction of a fabric made by a lady student in the Art and Textile Departments of the Dundee Technical College and School of Art. The loom or frame was also constructed in the College. The warp threads were first arranged on the upper beam, passed through a reed containing about 14 splits or dents per inch, and tied to the bottom roller. Top and bottom rollers or beams are provided with ratchet wheels and pawls, so that the work may be arranged in the most convenient position for the weaver, and for the operation of weaving. It will be seen that each alternate thread s controlled by a separate cord.

The illustration in Fig. 118 naturally exhibits the right side of the fabric, but since it is a tapestry structure, the ornament of which is developed by coloured weft yarns on the flat treatment (not pile structure) and by plain weaving, the work was conducted from the other side of the frame to that llustrated. All loose ends or short floating weft yarns are thus at the back of the fabric. The ground threads of the warp are completely covered with the various colours of weft on the principle of weaving illustrated in Fig. 10, and the structure or build of the fabric corresponds to condition II (p. 51).

The framework of a somewhat similar loom, and one method of attaching the ground or warp threads to the rod of the cloth-beam, is illustrated in Fig. 119.

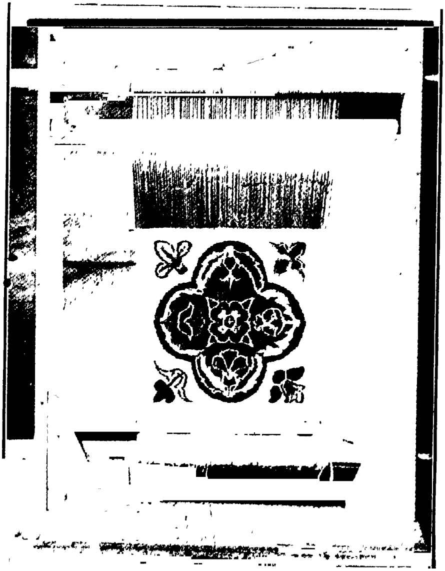


Fig. 118.

A comparatively long warp appears on the warp beam near the top of the frame, and the beam is controlled by a ratchet wheel and pawl on the left. The threads then pass over the upper bar, and down to the rod of the cloth-beam. The latter is provided with a cloth of the type illustrated at W, Figs. 96

and 97, but at present tied up by a string at each side to show the construction of the cloth.

Before the warp threads are tied to the rod of the cloth-beam, however, they should be drawn through a reed as explained in reference to Fig. 118, and the reed is then suspended on the short bars which are attached to the two inner faces of the end frames. The illustration shows that the weaver's lease is still intact at the ends of the warp threads, and that the warp is ready for being "gaited" or mounted preparatory to actual weaving.

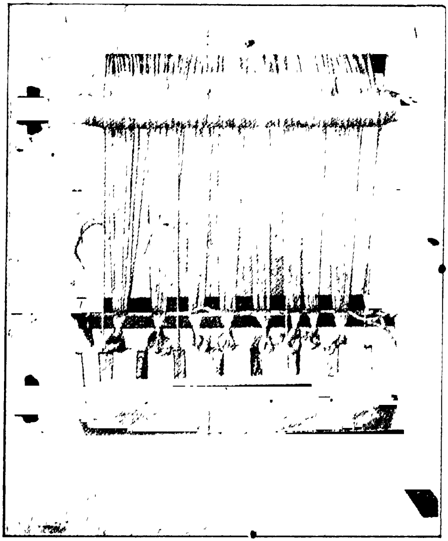


FIG. 119.

Figs. 120 and 121 are respectively end and front elevations of a somewhat similar frame. The warp

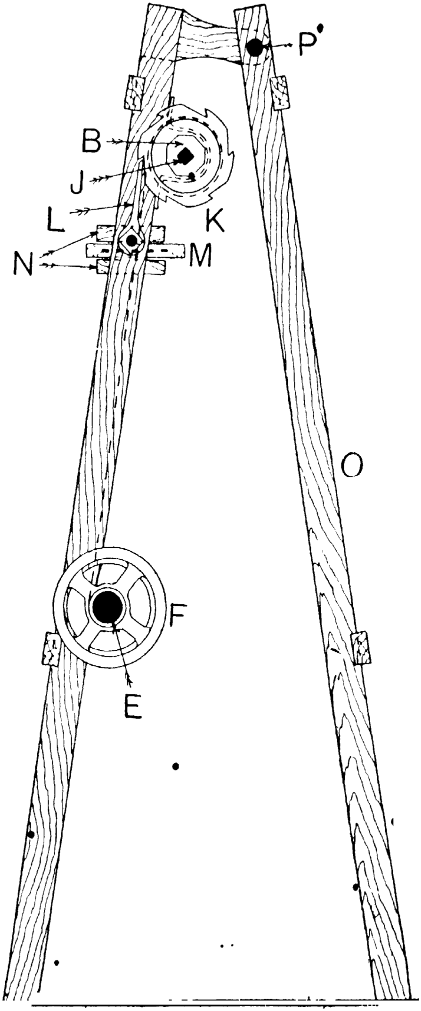


Fig. 120.

threads A are shown distinctly on the warp-beam B in Fig. 121, and disposed on the beam rod C in the cut-out parts of the cloth D belonging to the cloth-beam E. The latter is operated by means of the hand

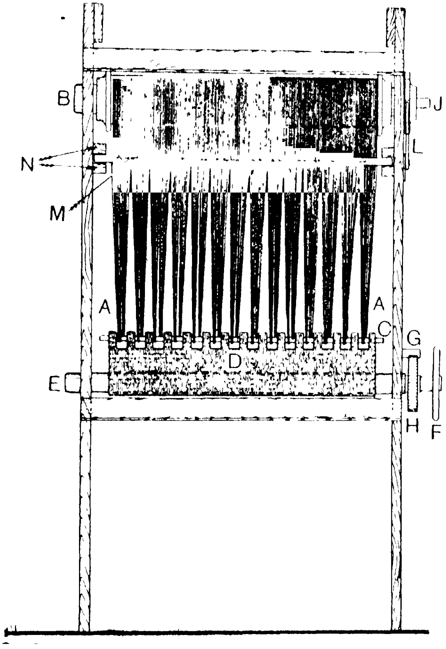


Fig. 121.

wheel F, and held stationary when required by the pawl G and ratchet wheel H.

It will be seen from the end elevation in Fig. 120 that the warp beam is provided with a gudgeon J, upon which is fixed a ratchet wheel K, and the latter is held a fixture or free to move by the action of the pawl L. The reed M is situated between the parts N, as shown in both figures, and if this reed is made on the same principle as leasing reeds (see Fig. 122), it forms an article by means of which alternate warp threads may be pulled to the front, or pushed towards the back, in order to form positively the two distinct sheds required for the weaving of plain cloth, or other arrangements which demand only two distinct movements of the warp threads. In Fig. 122 one shed is formed by the eight threads illustrated; the reed is supposed to have been drawn towards the

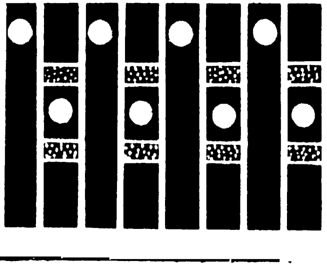


FIG. 122.

weaver, when the four threads enclosed in the leaded dents (the lead indicated by the stippled parts) would clearly move with the reed, while the remaining four would be unaffected; a movement of the reed from the weaver would carry the enclosed four threads to the far side of those which are at present near the far board of the reed. Pile fabrics, similar to Oriental fabrics and the like, can be woven in these looms. In some primitive looms, a wooden structure, similar to the reed in Fig. 122, is used for the same purpose.

Since the back frame O, Figs. 120 and 121, is fulcrumed at P, the whole frame may be collapsed, so that when weaving is finished the minimum amount of space will be occupied by the two frames. The total height of the frame is about 5 ft. 6 in., and its width is 3 ft. 6 in.

It appears most remarkable that, in spite of the very many ingenious methods of forming the shed, as exemplified in the foregoing chapters, very few weavers adopted the simple method of employing two distinct leaves of the healds and attaching the two leaves to the same simple lever, and operating the leaves by means of two simple treadles or cords.

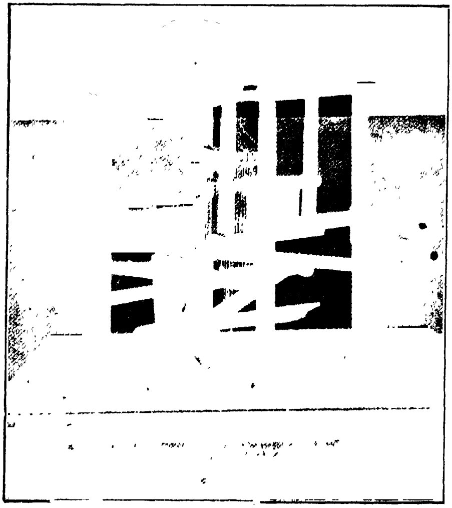


FIG. 123.

Fig. 123 illustrates a small hand-loom capable of operating any number of leaves to a maximum of eight. The leaves are pulled down by simple levers against the action of spring-controlled hooked levers on the left, and the hooked parts of the latter hold the leaves down for any number of shots or picks. Such a loom, although really a model and of a handicraft nature, is more an imitation of modern hand-looms than any which have been described in this work.

INDEX

Apparatus for weaving, simple, 11
Ardebil carpet, 129
Arrow-head twill, *see* Herring-bone twill
Attaching warp threads to weaver's beam, 115
Axminster (Real) fabrics, 132, 152, 155

Bagpipe, narrow fabrics for, 75
Bank, *see* Warping creel
Bar-trees, *see* Warping woof
Basse-lisse, *see* Horizontal loom
Bayeux tapestry, 22, 126
Beaming, 113, 115
— frame, 120, 124
Beating up, 144, 149
Bout and half-bout, 104, 106, 107, 108, 120
Buckingham Palace, carpet for, 152

Calico, 3
Cambs, *see* Healds
Cardboard devices for weaving or darning, 11, 13, 15, 24
Chain, *see* Warp
Cheese, 93, 95
Clasp-rods, 30, 112
Colour effects and methods of obtaining them, 18, 52, 73, 105, 126
Coloured yarns, 50, 97, 125, 139, 146
Cops, 91, 93, 97
Counts of yarn, 7
Creel, *see* Warping creel

Darning, 4, 16, 22
Design, 42, 43, 45, 46, 60, 79, 81, 125, 126, 140, 141
Design paper, 7
Diamond pattern, 42, 63, 84, 85
Difference between darning and weaving, 4
Dobby, 49
Donegal fabrics, 132, 155
Draft, 11, 22, 49, 81
, method of obtaining, 49, 50, 81
Drawing in, 115
Dressing machine, 105, 112

Early efforts of weaving, 26
Effects obtained by coloured yarns, 21, 50, 52, 53, 55, 56, 74, 104, 105
Embroidery, 22
Endless warps, 65
Evener, *see* Raddle
Eyes, *see* Mails

Fell of cloth, 72, 142, 150
Flanges, 95, 114
Flat or sisters, 33
Floats, 41, 63
Frames, 125, 155
Fringe, 74, 75

Gaiting, 157
Gears, *see* Healds
Glass, picks per, 37
Gobelin fabrics, 125, 126, 127
Guide-eyes, 96

Hand-loom, 27, 49, 87, 144, 162
— — as a competitor with power-loom, 86

Hand selection, 49, 60, 61, 62, 63, 76, 125, 128
Haute-lisse, *see* Vertical loom
Heald-rod, 37, 38, 39, 40, 43, 45 46, 50, 57, 58, 59
— —, method of making, 34
— —, method of using, 38, 39, 41, 45
Healds, 22, 49, 57, 79, 108, 12 161
Heck, 108
Heck-box, 108
Heddle-eyes, *see* Mails
Herring-bone twill, 11, 48
Hessian, 3
Holy carpet, 129
Horizontal loom, 126

Journeys or bouts, 102, 104, 110, 111

Kirman rug, 130
— —, British reproduction of, 130

Lease, picking the, 98, 137, 138
Leases, different kinds of, 33, 34 96, 100, 101, 103, 104, 105 111, 112, 113, 114, 120, 157
Lease rods, 113
Leasing reeds, 160
Leaves, 46, 49, 50, 81, 161
Linking the chain or warp, 109
Loom beam, *see* Weaver's beam

Mails, 22
Mexican cottage, interior of a, 53

Native cloth, 37, 40, 47

Objective in weaving, 5
Operation of weaving, 1
Oriental fabrics, 126, 127, 152, 160

Persian fabrics, 129, 132, 138 144, 155
Persian nomads, 65
Pile, method of introducing, 144, 146
Pile, plush or velvet weaving, 63, 126
Pillow linen, 3
Pinfuls, 120
Point paper, 7
Porter of cloth, *see* Sett of cloths
Power-loom, 27, 49, 79, 87

Queen Matilda, 126

Raddle, 117, 120, 121, 124
— —, adjustable, 121
Reed, 10, 64, 144, 160
Reversible fabric, 50
Roll, *see* Cheese

Selection of pile threads, 146
Selvage of Persian rug, 146, 151
Sett of cloths, 14, 36
Setting or spacing of warp threads, 13, 15, 36
Shed, 24, 30, 39, 52, 58, 137, 142, 143, 161
Shedding, 27, 29, 45, 125, 140
Shrinkage, 10, 17, 133
Simple apparatus for weaving, 11
Simple interweaving, 8
Simplest type of cloth, 3
Sley, *see* Reed
Spinning, 2, 91
Spools, *see* Cheese
String, 88, 90
Swivel fabrics, 63
Symmetrical pattern, warping, 106

Tapestry, 127
Temple, 57
Textile design, 2
Thrum, weaver's, 122
Tray-looms, 67, 75
— —, method of working 71, 74, 76
Tufting yarns for rugs, etc., 139, 140
Twill, 11
Twisting in, 115
Tying on, 115

Unit weave, 39, 43, 45
Unsymmetrical pattern, warping, 106

Velvet, *see* Pile
Vertical loom, 125, 132

Warp, 1, 8, 24, 27, 55, 64, 65, 105, 110, 111, 113, 117, 124, 142
 —, preparation of, 86, 88, 95, 96
 — selvage, [illegible]5, 138
Warping creel, 88, 91, 92, 93, 95, 107, 110
 —, methods of indicating order of, 21, 133
 — mill, 107, 108, 110, 113
 — with coloured yarns, 97, 103, 106
 — woof, 87, 88, 95, 101, 108, 113
Warps, Eastern method of making, 87
Waste, 121[illegible]122
Weaver's beam, 114, 115, 124
 — —, attaching warp threads to, 115
Weaving, chief operation of, 27
 — on frames, 42, 43, 55, 64
 — — on simple frames, 27
 — plan, 22, 46, 47, 79
 —, process of, 3
 —, slack, 124
Weft, 1
Wilton carpets, 154
Winding-on, *see* Beaming
Woof, *see* Weft
Woven texture, definition of, 127